APPENDIX 1

Echo integration-trawl survey of walleye pollock (*Theragra chalcogramma*) on the southeastern Bering Sea shelf and in the Aleutian Basin near Bogoslof Island in February and March, 2001

by Taina Honkalehto, Paul Walline, Denise McKelvey, and Neal Williamson

ABSTRACT

An echo integration-trawl (EIT) survey of walleye pollock (*Theragra chalcogramma*) was conducted on the southeastern Bering Sea shelf and in the Bogoslof Island area during the winter of 2001. The first leg of the survey took place 19 February to 3 March and covered an area of the southeastern Bering Sea shelf north of Cold Bay, AK, to northeast of Umnak Island. The second leg took place 5 to 11 March and covered the southeastern Aleutian Basin adjacent to the Aleutian Islands north of Unalaska Island to west of the Islands of Four Mountains. On the Bering Sea shelf, pollock were most concentrated northeast of Unimak Island. They were also concentrated near the 200 m isobath. In the Bogoslof area (west of 166°W long. and south and west of the 500 m isobath) pollock were limited to a few regions and were most concentrated in the Samalga Pass area.

The population estimate from this EIT survey for pollock between 14 m from the surface and 0.5 m off bottom was 1.595 billion pollock and 1.057 million metric tons (t) for the entire area surveyed. Of that, the estimate for pollock inside the SCA was 1.467 billion pollock and 0.968 million t. Estimated pollock abundance for the portion of the shelf surveyed was 1.424 billion fish and 0.825 million t. For Bogoslof, we estimated 171 million fish and 0.232 million t. Of the Bogoslof estimate, the abundance of pollock estimated to be inside U.S. management area 518/CBS specific area was 150 million fish and 0.208 million t. Pollock abundance, distribution and biological composition was compared and contrasted between the shelf and Bogoslof and between years.

INTRODUCTION

Scientists from the Midwater Assessment and Conservation Engineering (MACE) Program of the Alaska Fisheries Science Center conduct research surveys of Bering Sea walleye pollock (*Theragra chalcogramma*) on an annual or biennial basis to estimate pollock distribution and abundance. Results presented here are from the echo integration-trawl (EIT) survey carried out from 19 February to 3 March 2001 on the southeastern Bering Sea shelf, and from 5 to 11 March 2001, in the Bogoslof Island area between central Unalaska Island and the Islands of Four Mountains, Alaska. The primary cruise objective for the Bering Sea shelf section was to assess abundance and distribution of pollock inhabiting the eastern portion of the sea lion conservation area (SCA) east of 168° W. The primary objective of the Bogoslof portion was to assess the abundance of pre-spawning pollock in the southeastern Aleutian Basin. The biomass estimate for pollock inside U.S. management area 518 (also known as the Central Bering Sea (CBS) specific area) obtained during this survey provides an index of Aleutian Basin pollock abundance which is discussed at each year's CBS Convention meeting. Secondary cruise objectives were to obtain biological information for other research projects as noted in the appendix.

METHODS

Acoustic Equipment

Acoustic data were collected with a Simrad EK 500 quantitative echo-sounding system (Bodholt et al.1989, Bodholt and Solli 1992) on the NOAA ship *Miller Freeman*, a 66-m stern trawler equipped for

fisheries and oceanographic research. Two split-beam transducers (38 kHz and 120 kHz) were mounted on the bottom of the vessel's centerboard extending 9 m below the water surface. System electronics were housed inside the vessel in a permanent laboratory space dedicated to acoustics. Data from the echo sounder were processed using Simrad BI500 echo integration and target strength analysis software (Foote et al. 1991, Simrad 1993) on a SUN workstation. Results presented here are based on the 38 kHz data.

Trawl Gear and Oceanographic Equipment

Two trawl nets were used to sample observed echosign depending on the depth stratum sampled. Midwater and near-bottom echosign was sampled using an Aleutian Wing 30/26 Trawl (AWT). This trawl had full-mesh wings constructed of nylon with polyethylene in the codend and aft section of the body. The headrope and footrope each measured 81.7 m (268 ft). Mesh sizes tapered from 325.1 cm (128 in) in the forward section of the net to 8.9 cm (3.5 in) in the codend. The net was fitted with a 3.2-cm (1.25-in) codend liner. A 1.27 cm (0.5-in) codend liner was used on two occasions on the Bering Sea shelf to target small pollock. The AWT was fished with 82.3 m (270 ft) of 1.9-cm (0.75-in) diameter 8x19 (wire) non-rotational dandylines, and 226.8-kg (500-lb, leg 1) or 340.2-kg (750-lb, leg 2) tom weights on each side. On or near bottom echosign was sampled with an 83/112 bottom trawl without roller gear, hereafter referred to as “bottom trawl”. Net mesh sizes ranged from 10.2 cm (4 in) forward and 8.9 cm (3.5 in) in the codend to 3.2 cm (1.25 in) in the codend liner. Headrope and footrope lengths were 25.6 m and 34.1 m (83.9 ft and 111.9 ft), respectively, and the breastlines measured 3.4 m and 3.2 m (11.3 ft and 10.5 ft). For both trawls, vertical and horizontal net opening and depth were monitored with a WESMAR third wire netsounder system attached to the headrope on most hauls. On some occasions a Furuno netsounder system was used. Both nets were fished with 5 m^2 Fishbuster trawl doors (1,250 kg).

On one occasion, a Methot trawl was used to target scattering in the upper water column. Its mouth was a square frame measuring 2.27 m (89.5 in) on each side. Mesh size was 2 mm x 3 mm (0.08 in x 0.12 in) in the body of the net, and 1 mm (0.04 in) in the codend. A 1.83-m (6-ft) dihedral depressor was used to generate additional downward force. A calibrated General Oceanics flow meter was attached to the mouth of the Methot trawl to determine the volume of water filtered during trawling. The Methot trawl was attached to a single cable that was fed through a stern-mounted A-frame.

Physical oceanographic data collected throughout the cruise included temperature/depth profile data obtained with a micro bathythermograph (MBT) attached to the trawl headrope and conductivity-temperature-depth (CTD) data collected with a Sea-Bird CTD system at calibration sites and other selected locations. Sea surface temperature, salinity, and other environmental data were collected using the *R/V Miller Freeman's* Scientific Computing System (SCS). Ocean current profile data were obtained using the vessel's centerboard-mounted acoustic Doppler current profiler system operating continuously in water-profiling mode.

Survey Design

Survey design differed slightly between the two areas covered during this EIT cruise. The first leg began on 19 February 2001 on the Bering Sea shelf north of Cold Bay, AK, and extended across the shelf to north of the east end of Umnak Island, ending on 3 March. The 22 north-south parallel transects spaced 8 nmi apart covered a 14,200 nmi^2 area. The second leg began on 5 March 2001 north of the center of Unalaska Island at about 167°18'W long., and proceeded westward to the western part of the Islands of Four Mountains near 170°15'W long., concluding on 11 March 2001 (Fig. 1). The 22 north-south transects spaced 5 nmi apart covered a 3,000 nmi^2 area. This year’s survey area for Bogoslof was reduced compared to previous years’ survey areas. Results from recent surveys have shown that the area occupied by pre-spawning Bogoslof pollock has grown smaller, and that the population could be adequately and more efficiently estimated by focusing effort on the regions adjacent to the Aleutian Island chain and

north of Samalga Pass. We reduced the northern extent of tracklines west of 168°W long., and thus eliminated an area where very few or no pollock had been observed in recent years. This eliminated area accounted for an average of less than 1% of the biomass estimated from the last four *Miller Freeman* surveys (1996, 1997, 1998 and 2000). It reduced the total Bogoslof survey area by about 1/3. Southern transect endpoints were at bottom depths of approximately 100 m on the Aleutian shelf but varied depending on bottom depth and fish echo sign.

Echo integration and trawl data were collected 24 hours a day at an average vessel speed of 10.9 kts on the shelf, and 11.5 kts in the basin. Acoustic system settings used during the collection were based on results from standard sphere calibrations and on experience from prior surveys. Trawl hauls were made to identify echosign and to provide biological samples. Average trawling speed was about 3 knots. For AWT hauls numbered 1 to 24, all of which were fished with 227 kg (500 lb) tom weights, the average vertical net opening was 22 m and ranged from 18 m to 30 m. AWT hauls numbered 25 to 36 used 340 kg (750 lb) tom weights. For the latter hauls the average vertical net opening was 27 m and ranged from 21 m to 35 m. Vertical net opening averaged 3 m for the bottom trawl. Standard catch sorting and biological sampling procedures were used to determine weight and number by species for each haul. Pollock were sampled to determine sex, fork length, body weight, age, maturity, and ovary weight of selected females. An electronic motion-compensating scale was used to determine all weights taken from individual pollock specimens. Fork lengths were measured to the nearest cm (e.g, a fish measuring between 49.5 cm and 50.5 cm was recorded as 50 cm) and recorded with a Polycorder measuring device (a combination of bar code reader and hand-held computer), then downloaded into a desktop computer. Maturity was determined by visual inspection and categorized as immature, developing, pre-spawning, spawning, or post-spawning. Other sampling included age-1 pollock, adult pollock tissue, and a variety of fish species for the seabird and sea lion prey study. These samples were stored frozen.

Target strength data, which are used to scale echo integration data to estimates of absolute fish abundance, were collected on fish under suitable conditions (e.g., low fish density, single species aggregations, unimodal size distribution, and calm seas). During these collection periods, repeated passes were made over aggregations of pollock at speeds of less than 4 kts. Biological data were obtained from trawl hauls made in conjunction with the acoustic data collection.

Calibrations using standard sphere techniques were made to monitor acoustic system performance. During calibrations, the *Miller Freeman* was anchored at bow and stern. Copper spheres with known backscattering characteristics were suspended below the transducers and acoustic returns were measured, following the procedure outlined by Foote et al. (1987). Sphere diameters were 60 and 23 mm for the 38-kHz and 120-kHz transducers, respectively. Split-beam target strength and echo-integration data from the copper spheres were collected to describe acoustic gain parameters and transducer beam pattern characteristics.

Data Analysis

Acoustic data collected between 14 m from the surface and 0.5 m off the bottom or to 1,000 m, depending on bottom depth, were examined for pollock and stored in a relational database. Where possible, these data were also partitioned into non-pollock fish, myctophid scattering layer, and other categories. Pollock length data from 35 hauls were aggregated into 6 analytical strata based on echosign type, geographic proximity of hauls, and similarity in size composition data. Estimates of pollock backscattering strength in the area represented by each stratum were calculated. These echo integration values were then summed and scaled using a previously derived relationship between target strength and fish length (TS = 20 Log FL - 66; Traynor 1996) and the length composition data, resulting in an estimate of numbers of pollock by size. Two length-weight relationships were determined from the trawl data, one for pollock on the eastern shelf and one for the Bogoslof area. These relationships were used to estimate

pollock biomass for each length category. Pollock exhibit sexual dimorphism with females reaching larger sizes than males at the same age, particularly at older ages. In the Bogoslof region, pre-spawning pollock aggregations usually are both tightly packed and vertically and/or horizontally stratified by sex. Because of both the high densities and stratification, it is sometimes difficult to obtain a random sample of lengths from these aggregations to estimate population size composition. Although we caught more females than males in Bogoslof, we assumed a 50:50 sex ratio and derived a population size composition using this assumption. As there was about a year lag time between a survey and completion of age-reading from that survey, age data were not available for winter 2001. However, age data from the winter 2000 EIT survey were available, and age-specific numbers and biomass were estimated for that year using age-length keys developed from the trawl data.

Numbers and biomass at length were estimated for pollock between 14 m from the surface to within 0.5 m from the bottom for the entire area surveyed. This area was divided into two regions, the eastern shelf (11,600 nmi^2), and the Bogoslof area (5,600 nmi^2). For consistency with the Bogoslof time series, a portion of the shelf survey (part of the 8 nmi spaced transects during leg 1) in waters typically included in the Bogoslof Island area survey was removed from the "shelf" and added to the "Bogoslof" survey area for population estimates and biological results on pollock. The area covered in the first leg of the survey but considered to be part of Bogoslof was west of 166°W long., and south and west of the Bering Sea shelf break in basin waters beginning at about the 500 m isobath and deeper. Estimates were also made for the CBS specific area, and the SCA.

Error bounds on the acoustic data were derived using a 1-dimensional (1D) geostatistical method as described in Petitgas (1993), Williamson and Traynor (1996), and Rivoirard et al. (2000). We chose geostatistical methods for computation of error (± 2 relative estimation error) because they account for the observed spatial structure and thus provide more realistic estimates of error than those derived from the random sample variance. The method was applied separately to the shelf and Bogoslof areas because transect spacing differed (8 and 5 nmi, respectively). Since part of the Bogoslof area was sampled with 8 nmi transect spacing, the two sections of the Bogoslof area were analyzed separately. The estimation variance for the combined total biomass was calculated by adding the estimation variances for the two sections. Sampling error bounds on the acoustic data were then used to provide error bounds on the estimates of biomass. These error bounds quantify only acoustic data sampling variability and hence should be treated as preliminary. Other sources of error (e.g., target strength, trawl sampling, error associated with ageing error) are not included**.**

RESULTS

Calibration

Four acoustic system calibrations were conducted: one during gear trials in Port Susan, WA; two in Captains Bay, AK, during the Bering Sea surveys; and one at the end of the winter field season in the Gulf of Alaska (Table 1). No significant differences in gain parameters or transducer beam pattern characteristics were observed for the 38-kHz collection system. The 120-kHz system is known to be somewhat temperature sensitive, but no significant differences in parameters were observed for the 120-kHz system during the Alaska field season.

Target Strength

One target strength collection was made on age 1 pollock. Results are still being analyzed and will be reported elsewhere.

Oceanography

Oceanographic data were collected from 36 trawl-mounted MBTs (Table 2), 5 CTDs (Fig. 1), and continuous surface thermosalinograph readings. Temperature profiles showed well mixed water columns both in the shelf area and in the basin (Fig. 2). Average temperature by 50 m depth intervals between the surface and 250 m was similar across the whole area, ranging from 3.8° to 4.2°C on the Bering Sea shelf and from 4.0° to 4.2°C in the basin. Observed basin temperatures were more variable than those on the shelf. Below 250 m, average basin temperatures declined steadily from about 3.9° to 2.4°C at 1,300 m.

Surface temperatures (Fig. 3) ranged from 2.7° to 4.8°C. Most surface waters were between 3.6° and 4.2°C. Adjacent pockets of warmer and cooler water were observed in the Aleutian basin. Coldest surface temperatures (less than about 3.0°C) were observed on transects 100 and 101 near the Alaskan Peninsula, and in basin waters north of Umnak Island and Samalga Pass between transects 215 and 220. Warmest waters (greater than about 4.2°C) occurred near the Aleutian chain in basin waters west of about 167°W long.. Surface salinity ranged from 30.9 to 33.3 ppt (Fig. 4). Salinities were lowest (less than about 31.3 ppt) in the east along the Alaskan peninsula and Umnak Island, and increased from east to west becoming highest (greater than 33 ppt) in the basin near Unimak Island and west.

Biological sampling

Biological data and specimens were collected from 36 trawl hauls: 32 using the AWT; three using the bottom trawl; and one with the Methot trawl (Tables 2 and 3, Fig. 1). Biological samples for several additional research projects, including prey studies and genetics, were also collected (Table 4). On the Bering Sea shelf, walleye pollock comprised 93% and 56% by weight of midwater and bottom trawl catches, respectively (Tables 5 and 6). Rock sole (*Lepidopsetta sp.*) comprised about 20% by weight of the bottom trawl catches. In the Bogoslof area, pollock comprised 99% by weight of the (midwater) catches (Table 7). Although the next most abundant species group in the Bogoslof area, myctophidae, comprised only 0.3% by weight, it represented 25% of the midwater catches by number.

Bering Sea Shelf

Length compositions of pollock from the 23 shelf survey trawl hauls were grouped into four analytical strata (Fig. 5a-d), three shelf strata and one shelf/Bogoslof transition stratum for the region traditionally part of the Bogoslof survey. Fork lengths ranged from 9 to 65 cm among pollock sampled in shelf area trawl hauls. Estimates of shelf pollock abundance by size indicated two dominant modes, one at about 46 cm and one at about 12 cm (Fig. 6). The mode of small pollock was from aggregations centered on the shelf north of the 200 m isobath, between transects 116 and 121. For fish greater than 29 cm long from hauls where more than 50 fish were sampled, catch sex ratios ranged from 23 to 65% male (Fig. 7). Most female (50%) and male (57%) pollock greater than 29 cm long (approximately ages 3+) were pre-spawning (Fig. 8a), although quite a high proportion, 35% of females and 22% of males, were developing. One percent of females and about 5% of males were actively spawning. Among pollock sampled that were smaller than 29 cm long, 96% were immature. Females were estimated to be 50% mature at 43 cm (Fig. 8c). Among female pollock greater than 38 cm long sampled in trawl hauls, the proportion mature varied by region (Fig. 9). Those in trawl hauls east of about 165°W long. had a higher proportion mature than those to the west. Average gonadosomatic index (GSI) for pre-spawning females on the shelf was 0.10 (Fig. 10a) . As was observed with proportion mature, the average GSI was higher between 163° and 165°W long., and lower west of 165°W long. (Fig. 10c). The regression equation of total body weight to length used in population analysis was $W = 0.00357 * FL^{3.1915}$, where W is weight, and FL is fork length for males and females combined (Fig. 11a).

Distribution of pollock was continuous across the first 11 transects on the shelf (Fig. 12). Transect 104 had the highest densities of pollock of all shelf transects and represented 18% of the estimated biomass. West of transect 110, pollock were more concentrated near the 200 m isobath. At transect 116, pollock

abundance increased between the 200 m isobath and the northern transect endpoints at 55°30'N lat. Echosign appearance differed between day, when pollock were densely aggregated either on or off bottom, and night, when pollock were more evenly distributed and loosely aggregated from the bottom into midwater. Echosign of juvenile pollock in the northwest survey area (as sampled by hauls 17 to 24, Fig. 1) looked slightly different during day than that of adult pollock, as the juveniles did not form as dense on-bottom aggregations. Instead, they tended to form medium-density scattering layers or schools about 5 to 50 m off bottom. Sometimes these juvenile pollock schools appeared in the upper water column.

Abundance estimates for pollock in the Bering Sea shelf survey area between 14 m below the surface and 0.5 m off-bottom were 1.424 billion fish and 0.825 million metric tons (t) (Fig. 13a). The relative estimation error of the shelf biomass based on the 1D analysis was 8.1%. This gives a 95% confidence interval of 0.691-0.959 million t. A very high biomass observed at a single point, resulting from a single, dense, near-bottom school, had great influence on the overall variance observed on the shelf. When this point was excluded from the analysis and replaced by the overall mean, the relative estimation error was reduced to 5.75%.

Although age data were not available from otoliths collected in winter 2001, age composition data were available from the winter 2000 eastern Bering Sea (EBS) shelf survey. In 2000 average length at age was fairly similar between males and females on the shelf (Fig. 14). Population estimates by age for EBS shelf pollock showed that in 2000, the 1992 and 1996 year classes each made up about 25% of the population by numbers. The 1995 year class was next most numerous, at about 20% of the population (Fig. 15a).

Bogoslof Area

Pollock encountered west of 166°W long., and south and west of the 500 m isobath were considered to be part of the Bogoslof pre-spawning population. Length compositions from hauls numbered 25 to 36 were grouped into two analytical strata (Fig. 5e,f). Two hauls from the shelf section of the survey comprised a shelf/Bogoslof transition stratum for the region traditionally part of the Bogoslof survey (Fig. 5d). Among pollock sampled in trawl hauls, fork lengths ranged from 38 to 70 cm. Size-based population estimates for Bogoslof pollock indicated that their average length was 55 cm. Catch sex ratios ranged from 7 to 85% male among pollock greater than 29 cm from hauls where more than 50 fish were sampled (Fig. 7). Most female (96%) and male (68%) pollock were in pre-spawning condition (Fig. 8b). One percent of females and about 26% of males were in spawning condition. The average gonadosomatic index (GSI) for pre-spawning females was 0.17 (Fig. 10b), the same as in Bogoslof in winter 2000, indicating that survey timing was similar in relation to peak spawning. The average Bogoslof GSI was much higher than the average shelf GSI, suggesting that spawning was more spread out in time, or occurred later on the Bering Sea shelf, or both. A marked increase in average GSI appeared at about 167°30'W long., in the shelf/Bogoslof transition area, and continued westward (Fig. 10c). The regression equation of total body weight to length used in population analysis for Bogoslof was $W = 0.0103 * FL^{2.934}$, where W is weight, and FL is fork length of males and females combined, assuming a 50:50 population sex ratio (Fig. 11b).

In the Bogoslof area, defined as west of 166°W long. and south and west of the 500 m isobath, most pollock echosign was observed along the Aleutian Islands (Figs.1 and 12). Low-density scattering layers occurred between the 500-m isobath and the Aleutian chain along transects 114 to 119. More pollock were encountered in a small submarine canyon the northeast corner of Umnak Island (between and including transects 203 and 204) where bottom depths were between about 500 and 1,000 m, and, as in previous years, most pollock were observed in a submarine basin area north of Samalga Pass and east of the Islands of Four Mountains. Aggregations were centered between 400 and 500 m in depth. In the

Samalga area, pollock aggregations were about 300 m thick, and were typically observed to extend horizontally for about 5-10 nmi.

The abundance estimate for pollock in the Bogoslof area between 14 m below the surface and 1,000 m (or to within 0.5 m off-bottom) was 171 million fish, and 0.232 million t (Table 8, Fig.13b). The relative estimation error of the Bogoslof pollock biomass estimate based on the 1D analysis was 10.0%. This gives a 95% confidence interval of 0.185-0.278 million t. The abundance of pollock estimated for the subset of Bogoslof pollock inside U.S. management area 518/CBS specific area (see Fig. 1) was 150 million fish and 0.208 million t, about 90% of the estimated population for the whole area (Table 8).

The population estimate for the SCA, obtained by adding together estimates from the shelf area excluding transects 100 and half of 101, and Bogoslof excluding transects 221, 222, and half of 220, was 1.467 billion pollock and 0.968 million t. The population estimate for the entire area surveyed was 1.595 billion pollock and 1.057 million t.

Biomass estimates from the EIT survey for pollock on the winter southeastern shelf and in the southeastern Aleutian Basin area, between 14 m below the surface and 1,000 m (or to within 0.5 m from bottom) in 2001 are summarized as follows:

Area	Million metric tons	
SCA	0.968	SCA includes Area 518/CBS specific area (0.208)
east of SCA	0.089	
west of SCA	0.000	
Total survey	1.057	

Pollock otoliths collected during this cruise were not yet analyzed and thus estimates of age composition for 2001 were not available. Age data from winter 2000 were analyzed. In winter 2000, average length at age was higher for Bogoslof area females than for Bogoslof males at most ages (Fig. 14). Population estimates by age showed that the 1989 year class was still dominant in the Bogoslof area (Fig. 15b). The 1992 year class was next most abundant, followed by the 1990 year class. In winter 2000, a small number of pollock from older year classes (1984,1982 and 1978) which represented most of the biomass in the Bogoslof population prior to 1993 were still present.

DISCUSSION

The first part of the winter 2001 survey on the southeastern Bering Sea shelf differed from the winter 2000 shelf survey in that it took place during 2 weeks rather than 4 days, had transects oriented north-south rather than east-west, and covered a much larger portion of the SCA. The same survey design had originally been planned for winter 2000, but poor weather and sea ice conditions limited that survey to 4 days, altered the transect design and spacing, and reduced the area covered. Water temperatures were warmer in winter 2001 than in 2000, probably due to warmer air temperatures and reduced sea ice cover on the shelf in 2001. Comparing and contrasting the biological results from 2001 and 2000 showed that modal lengths of the adult pollock increased from about 42 cm in 2000 to about 46 cm in 2001. Maturity was similar for both sexes between years, and the length at 50% maturity for females was 43 cm for both years. Estimated pollock abundance on the eastern shelf in 2001 (0.825 million t) was about the same as in 2000 (0.816 million t). However, abundance results are not strictly comparable due to the difference in shelf areas surveyed between 2000 (5,000 nmi^2) and 2001 (11,600 nmi^2, not including the area included in Bogoslof). For example, aggregations of age-1 pollock were observed near the 200-m isobath in 2001 in an area not surveyed in 2000.

In the second part of the winter 2001 survey, we monitored pollock in the Bogoslof Island area for the 12th time in 13 years (including a Fisheries Agency of Japan survey in 1999 in which the U.S. participated). Pre-spawning pollock aggregate in this area in February and March each year (Honkalehto and Williamson 1995, 1996), and spawn between the end of February and mid-March. During the earliest survey years (1989-92), Bogoslof pre-spawning pollock occupied a large area of the southeast Aleutian basin extending from east of Bogoslof Island westward to the Islands of Four Mountains and Samalga Pass, with highest concentrations surrounding Bogoslof Island. At that time they were subject to a large commercial fishing effort which was halted in 1992 due to pollock population decline there and in international waters of the Aleutian Basin also known as the donut hole.

In 2001, as in recent years (1998 and 2000), pollock were highly concentrated in Samalga Pass (76% of biomass in 2001, 73% in 1998 and 72% in 2000), and were otherwise sparsely distributed within the Bogoslof area. There was no significant change in population between 2000 and 2001 (95% confidence intervals overlap, Table 8). However, Bogoslof population estimates from EIT surveys show biomass decreasing with time (Fig. 16). No significant recruitment from younger year classes has occurred since the 1989 year class began appearing in about 1994 (Tables 9-12, Fig.17). Tracing numbers by age of dominant Bogoslof year classes (Figs. 18 and 19) showed that the 1989 year class became the main component of the population at age 5, replacing the 16-year-old 1978 year class in 1994. As of 2000, estimated numbers of the1992 year class were highest at age 7 in 1999; suggesting that they may not continue to boost the population size in the future.

Although Bogoslof pre-spawning pollock aggregations appear to have the same dominant age classes as pollock aggregations observed on the EBS shelf, the proportions of those dominant age classes relative to the total population often differ. Within year, in the winter, Bogoslof fish appear distinct from those pre-spawning pollock inhabiting the Bering Sea shelf. In 2000, the 11-year-old 1989 year class dominated the Bogoslof population followed by the 1992 year class and there were many older fish, while the 1996 year class dominated the shelf population (Fig. 15). Average length at age was higher for both sexes in Bogoslof than on the shelf (Fig. 14). A much higher proportion of females were in pre-spawning condition and the average GSI was much higher in Bogoslof (Fig. 8). Although its contribution to the overall Bering Sea pollock gene pool is not known, the Bogoslof population is unusual in that its deep-water spawning aggregations are composed of larger, relatively older fish with higher average GSI than pollock found on the shelf.

SCIENTIFIC PERSONNEL

Leg 1 (19 February-3 March)

Name	Sex/Nationality	Position	Organization
Neal Williamson	M/USA	Chief Scientist	MACE
Kevin Landgraf	M/USA	Fish. Biologist	MACE
Paul Walline	M/USA	Fish. Biologist	MACE
John Horne	M/USA	Fish. Biologist	MACE
Denise McKelvey	F/USA	Fish. Biologist	MACE
Phil Porter	M/USA	Computer Specialist	MACE
Sarah Stienessen	F/USA	Fish. Biologist	MACE
Steve de Blois	M/USA	Fish. Biologist	MACE
Hyun-Su Jo	M/Korea	Fish. Biologist	NFRDI

Leg 2 (5-11 March)

Name	Nationality	Position	Organization
Taina Honkalehto	F/USA	Chief Scientist	MACE

Steve de Blois	M/USA	Fish. Biologist	MACE
Kevin Landgraf	M/USA	Fish. Biologist	MACE
Paul Walline	M/USA	Fish. Biologist	MACE
Mike Brown	M/USA	Computer Specialist	MACE
Steve Porter	M/USA	Fish. Biologist	FOCI
William Floering	M/USA	Fish. Biologist	MACE
Hyun-Su Jo	M/Korea	Fish. Biologist	NFRDI

MACE - Midwater Assessment and Conservation Engineering Program, Alaska Fisheries Science Center, Seattle, WA
FOCI - Fisheries Oceanographic Coordinated Investigations, AFSC, Seattle, WA
NFRDI – National Fisheries Research and Development Institute, Pusan, Republic of Korea

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Williamson, N and J. Traynor. 1996. Application of a one-dimensional geostatistical procedure to fisheries acoustic surveys of Alaskan pollock. ICES Journal of Marine Science, 53: 423-428.

Appendix– Other Research Projects–List of Contacts

Legs 1 and 2 (EBS shelf and Bogoslof)

Research Objective	Contact	Organization/Email address
Fecundity collection	Bern Megrey	AFSC/ Bern.Megrey@noaa.gov
Fecundity collection	Hyun-Su Jo	NFRDI/hsjo@haema.nfrda.re.kr
Whole fish collection and sea lion and seabird prey study	Alan M. Springer	U. of AK/ ams@ims.uaf.edu
Stomach collection from non-spawning pollock	Pat Livingston,	AFSC/Pat.Livingston@noaa.gov
Pollock fin clips	Mike Canino,	AFSC/ Mike.Canino@noaa.gov

Leg 2 (Bogoslof)

Research Objective	Contact	Organization/Email Address
Spawn pollock	Steve Porter,	AFSC/steve.porter@noaa.gov

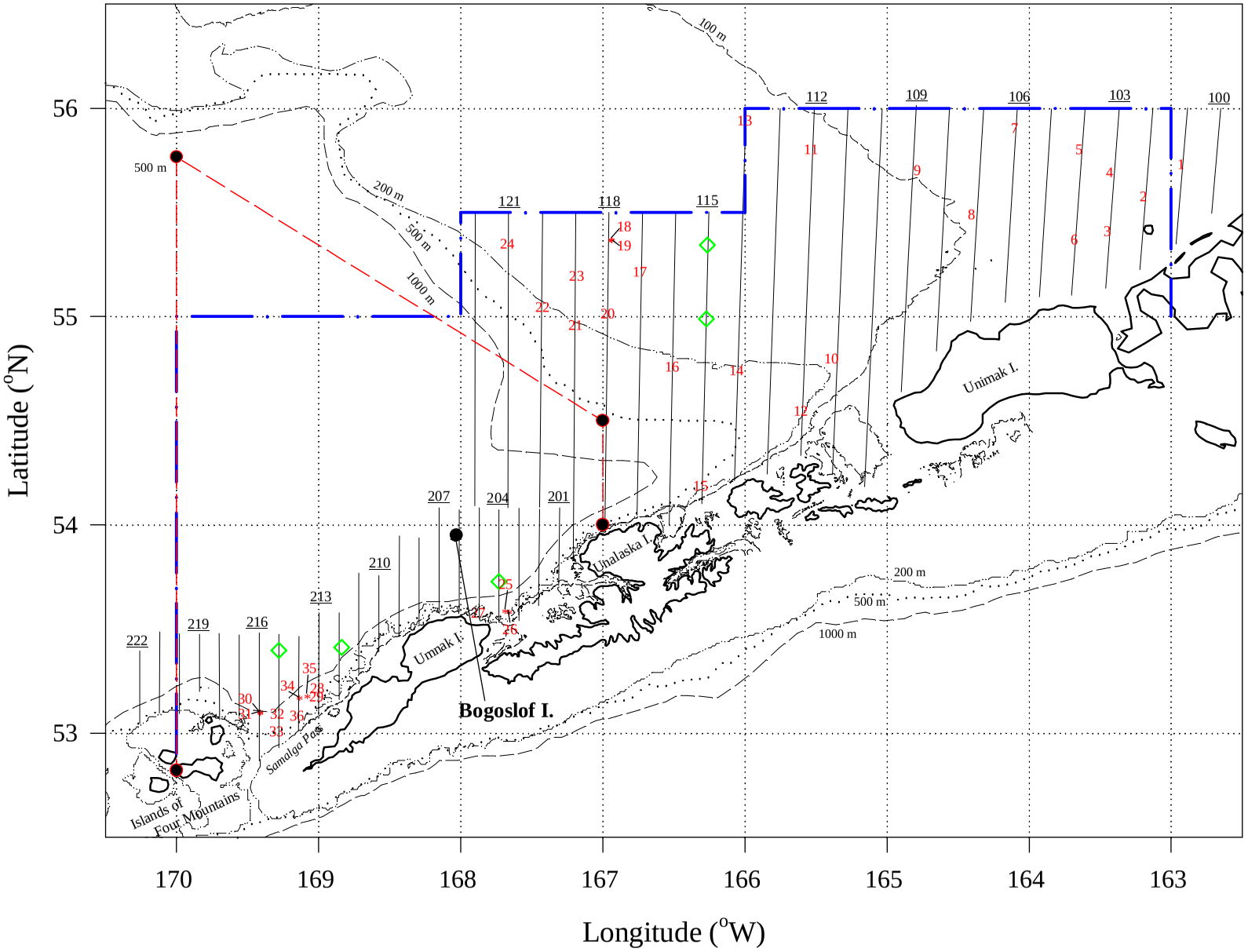


Figure 1. Trackline and haul locations from the winter 2001 echo integration-trawl survey of the southeast Bering Sea shelf and Bogoslof Island areas. Transect numbers are underlined. Conductivity-temperature-depth (CTD) sample locations are indicated by diamond symbols. Dash-dotted line indicates boundary of the sea lion Conservation Area (SCA), and dashed line outlines U.S. management area 518/Central Bering Sea specific area.

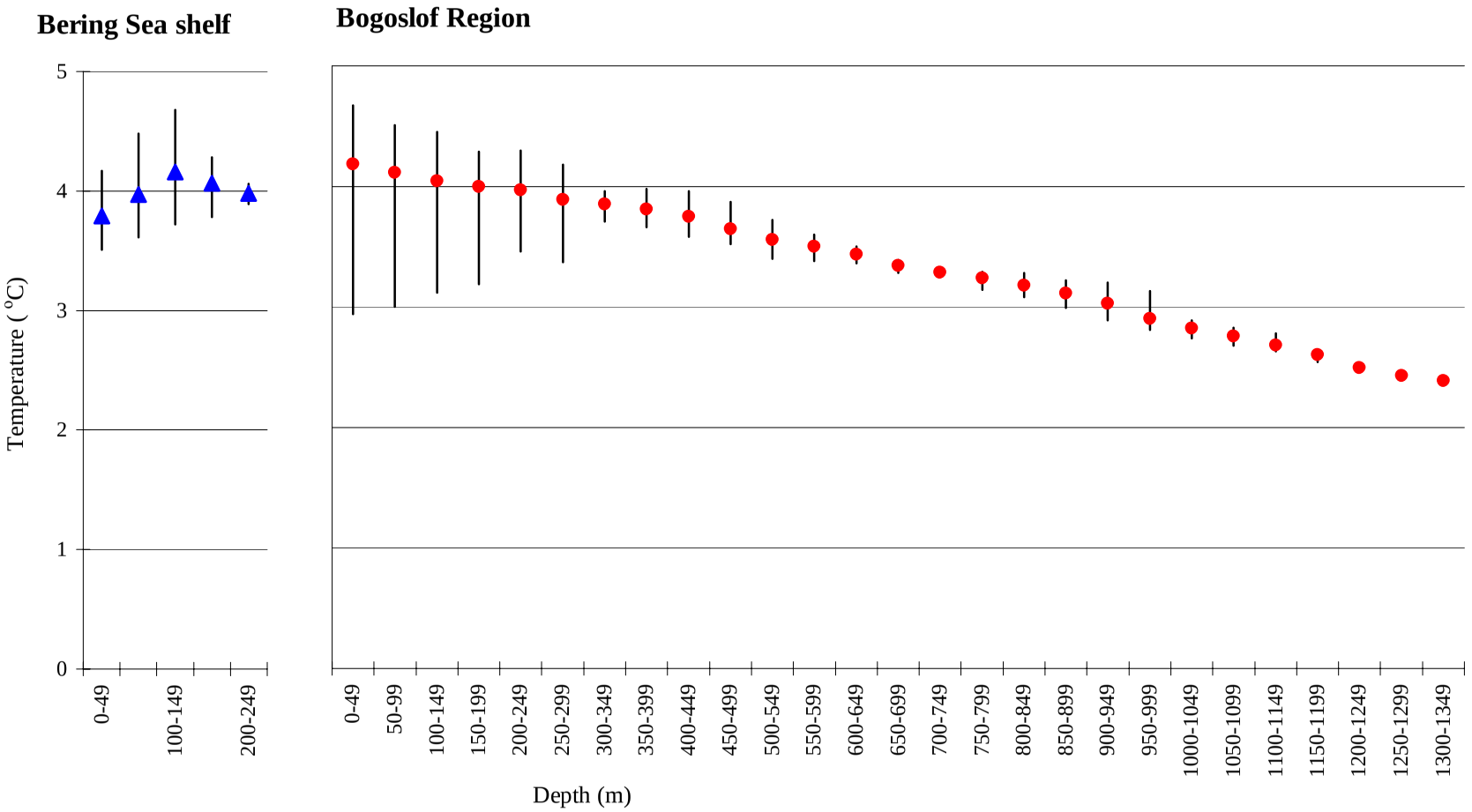


Figure 2. Average temperature (^{o}C) (symbols) and range (vertical bars) by 50-m depth intervals observed during the southeastern Bering Sea shelf and Bogoslof region.

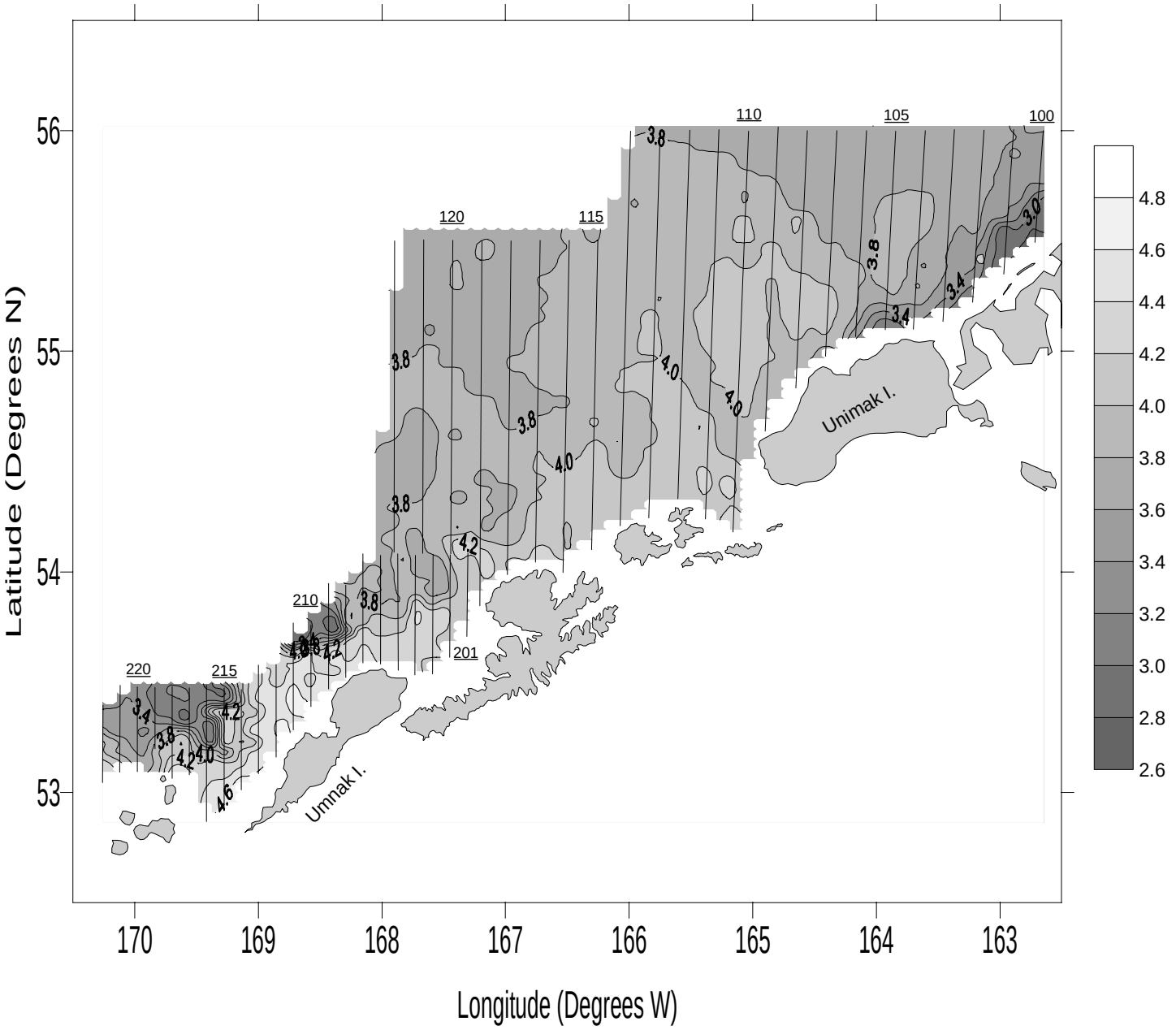


Figure 3. Transect lines with surface temperature contours (in degrees C) during the winter 2001 echo integration-trawl survey of the southeast Bering Sea shelf and Bogoslof Island areas. Transect numbers are underlined.

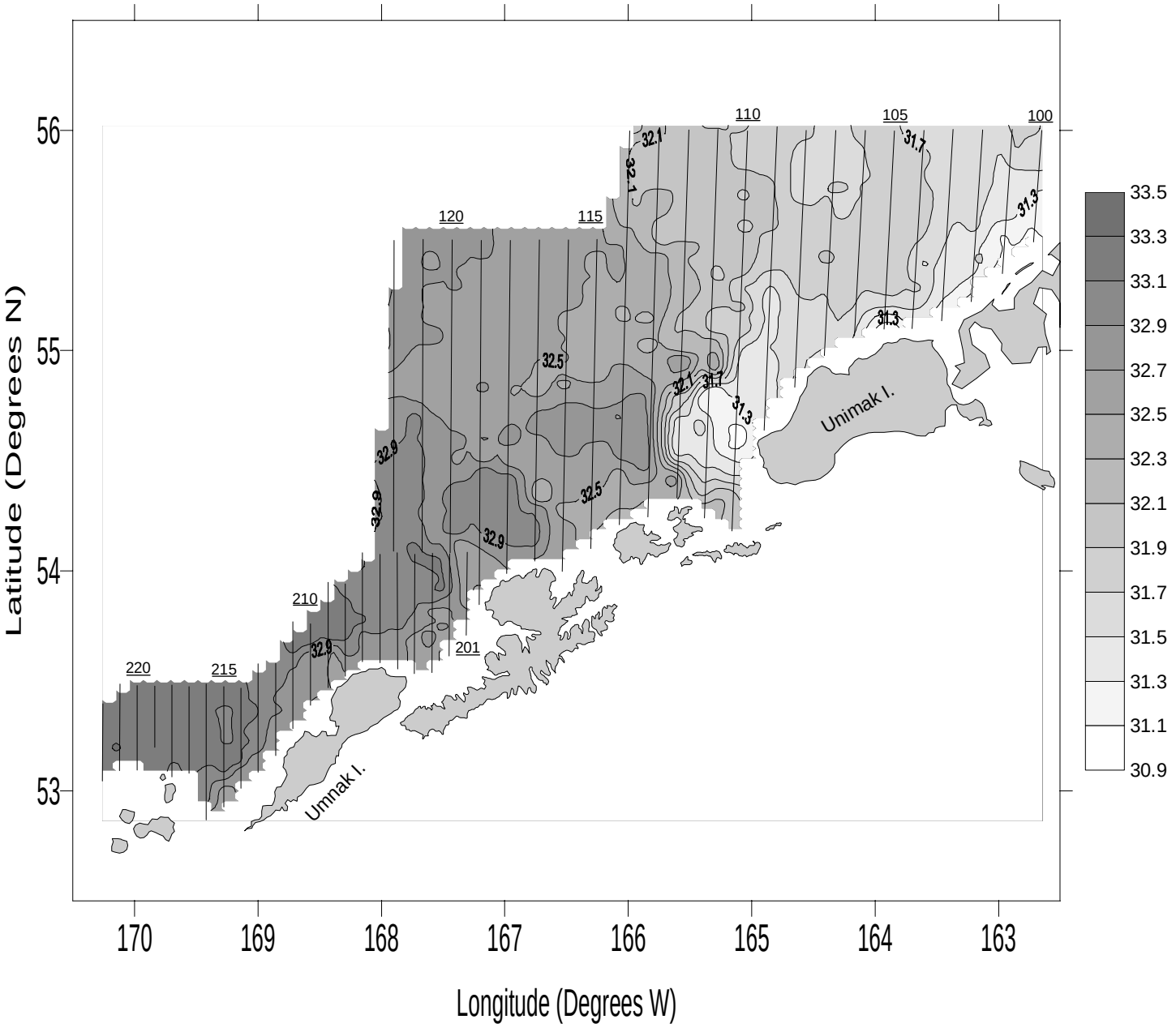


Figure 4. Transect lines with surface salinity contours (in ppt) during the winter 2001 echo integration-trawl survey of the southeast Bering Sea shelf and Bogoslof Island areas. Transect numbers are underlined.

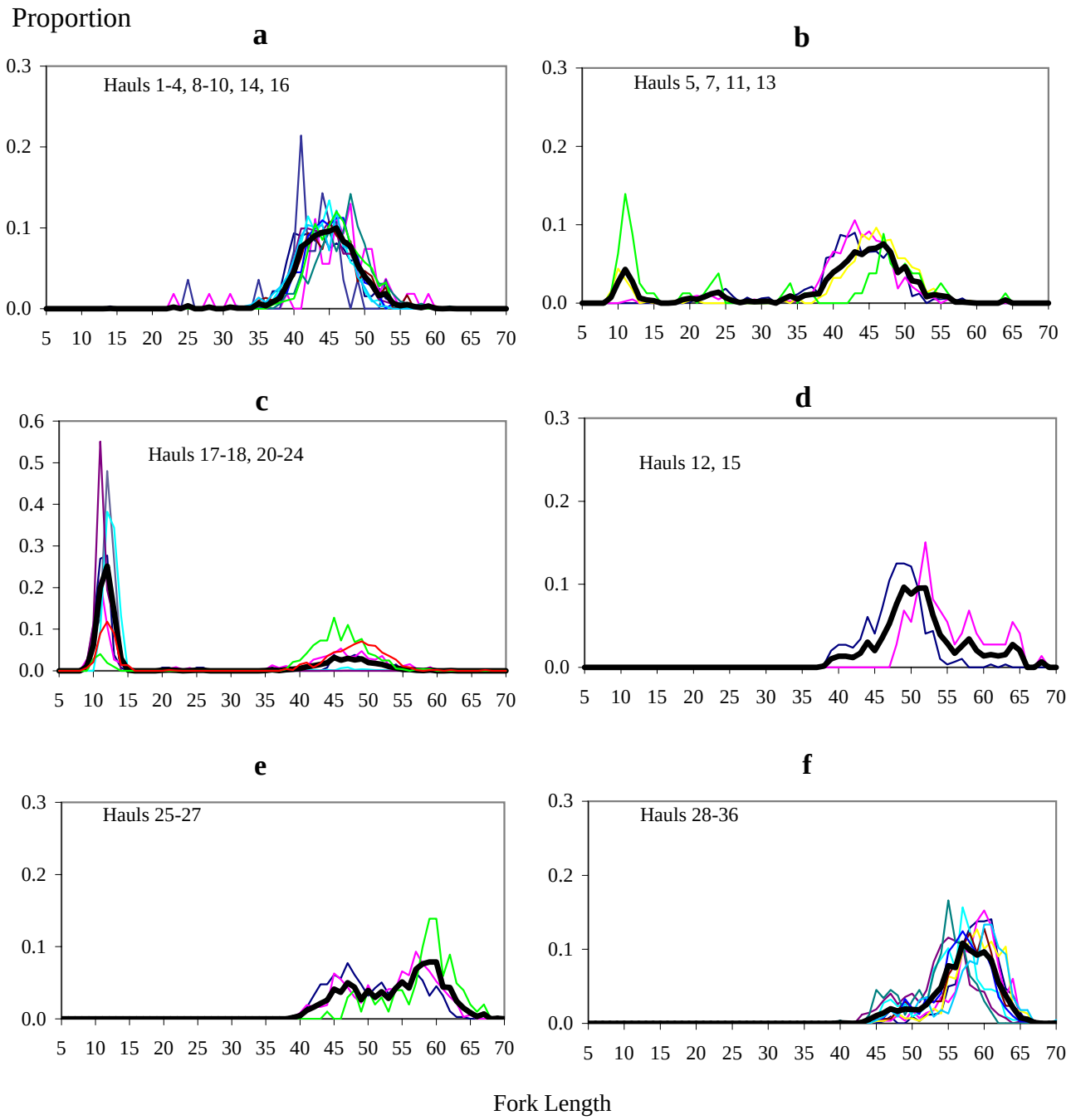


Figure 5. Pollock proportions by length from raw haul data, and haul data averaged (heavy line) by stratum for the southeastern Bering Sea shelf (a-c), shelf/Bogoslof transition zone (d), and the Bogoslof area (e-f).

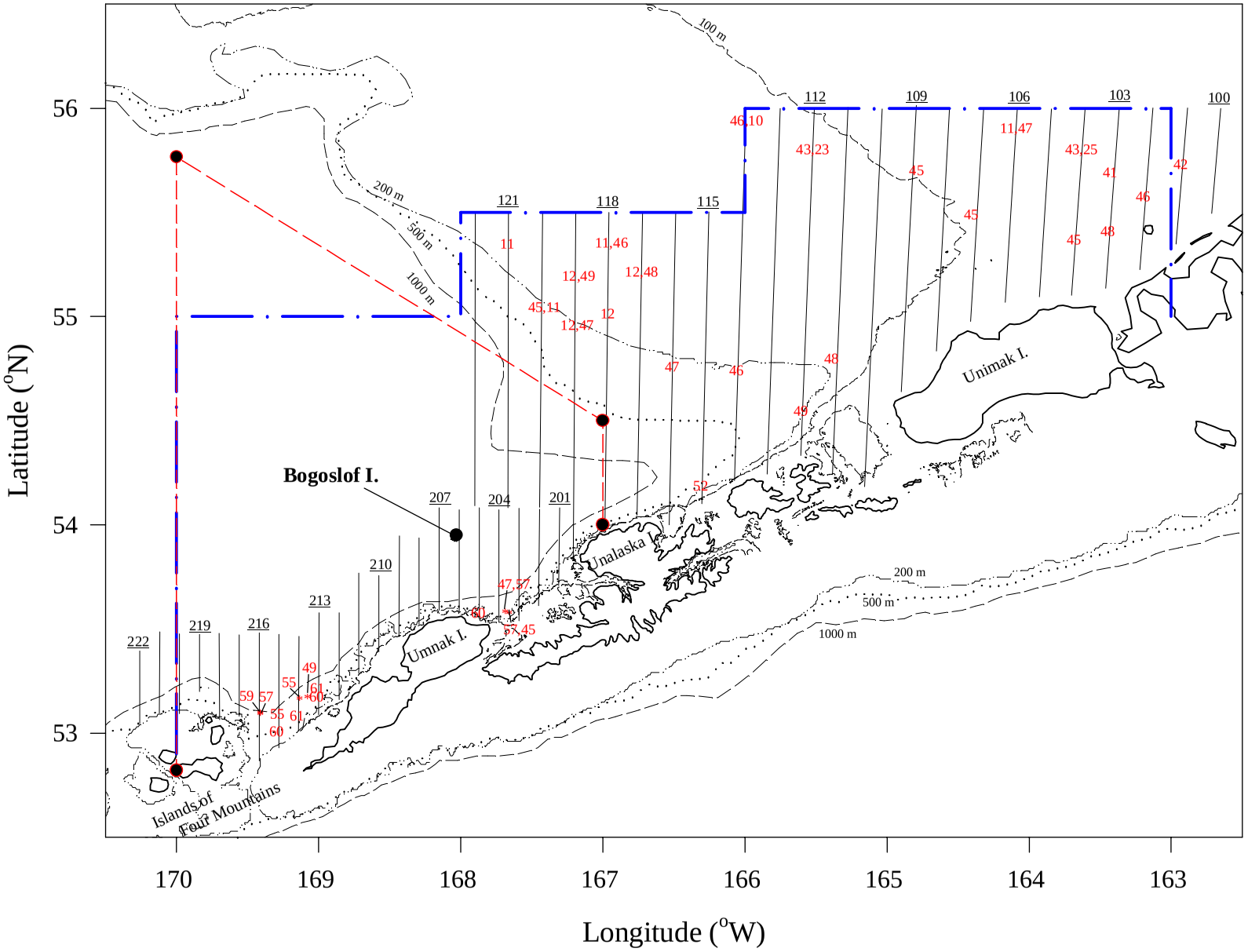


Figure 6. Trackline and haul locations with pollock modal and bimodal lengths (cm) from the winter 2001 echo integration-trawl survey of the southeast Bering Sea shelf and Bogoslof Island areas. Transect numbers are underlined. Dash-dotted line indicates boundary of the sea lion Conservation Area (SCA), and the dashed line outlines U.S. management area 518/Central Bering Sea specific area.

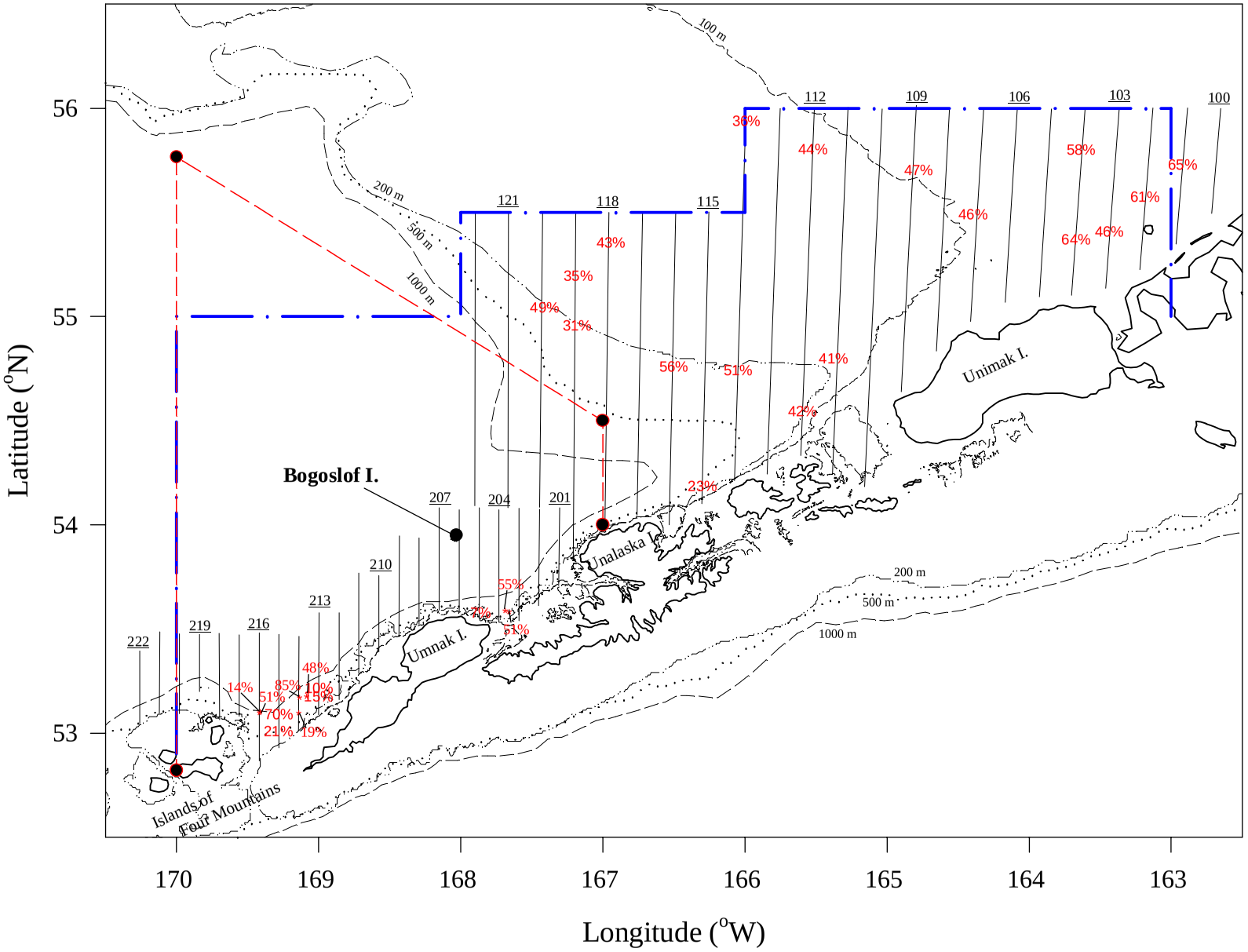
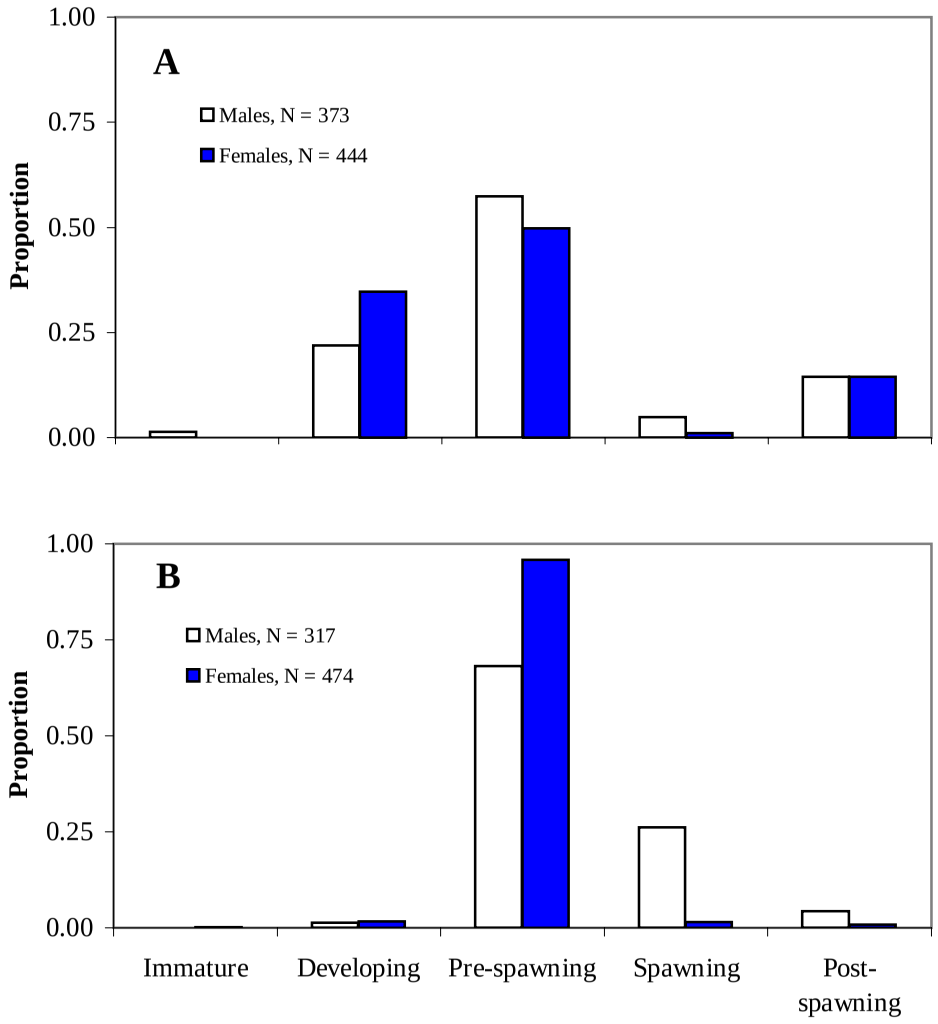


Figure 7. Trackline and haul locations with percent male pollock > 29 cm (N > 50) from the winter 2001 echo integration-trawl survey of the southeast Bering Sea shelf and Bogoslof Island areas. Transect numbers are underlined. Dash-dotted line indicates boundary of the sea lion Conservation Area (SCA), and the dashed line outlines U.S. management area 518/Central Bering Sea specific area.



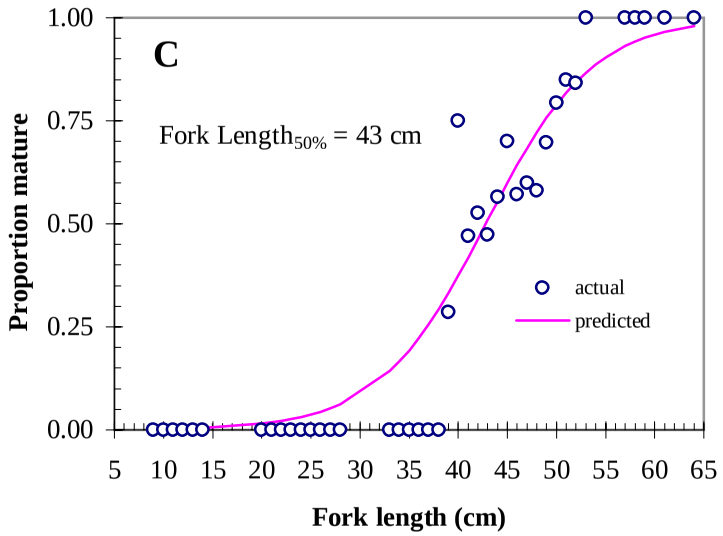


Figure 8. Pollock (> 29 cm) maturity stages observed during the winter 2001 echo integration-trawl survey of the southeastern Bering Sea shelf (A) and Bogoslof Island area (B). Fitted logistic function and proportion mature at each size class for female pollock observed in the southeastern Bering Sea shelf region (C). Fork $Length_{50\%}$ is the predicted fork length of fish that are 50% mature.

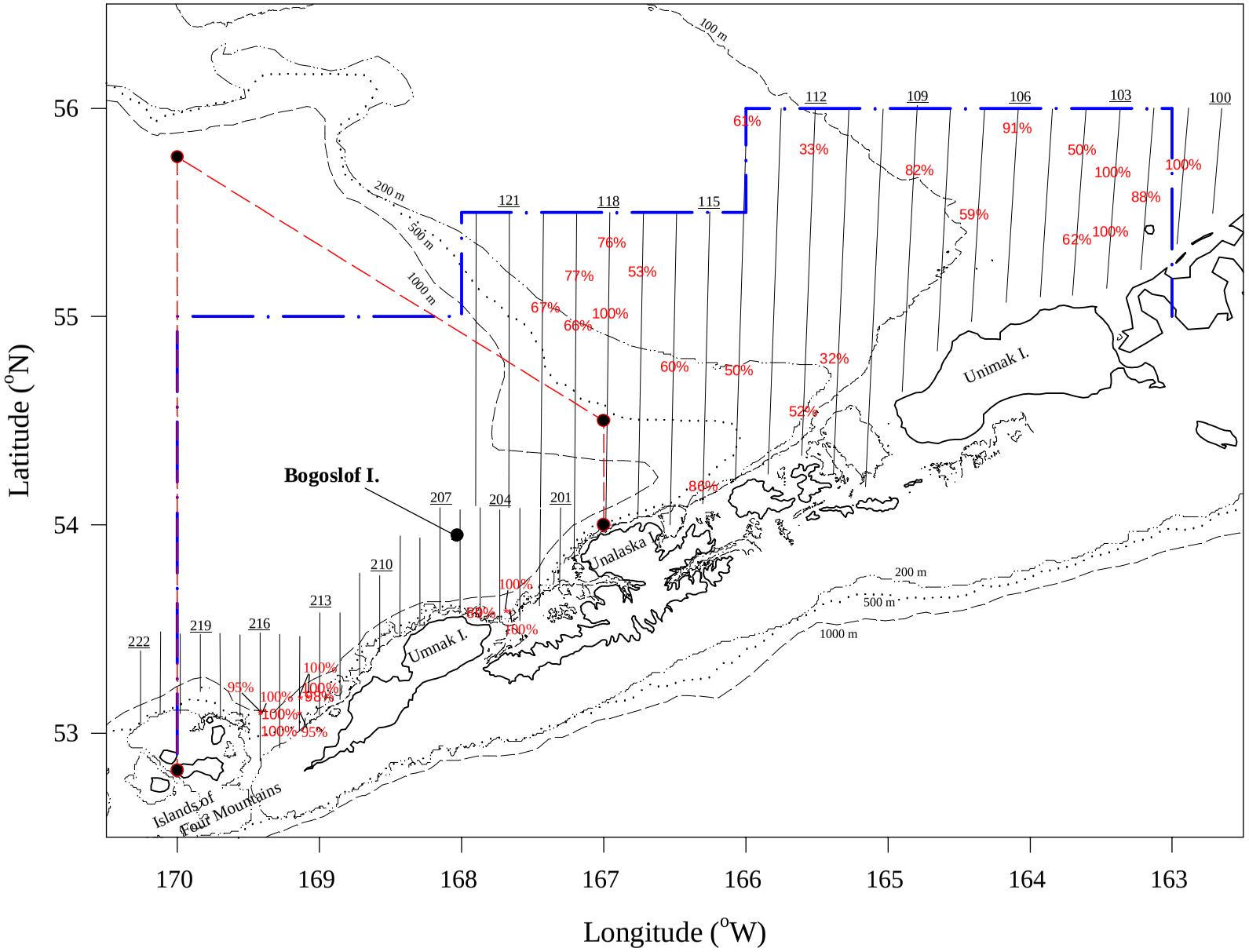
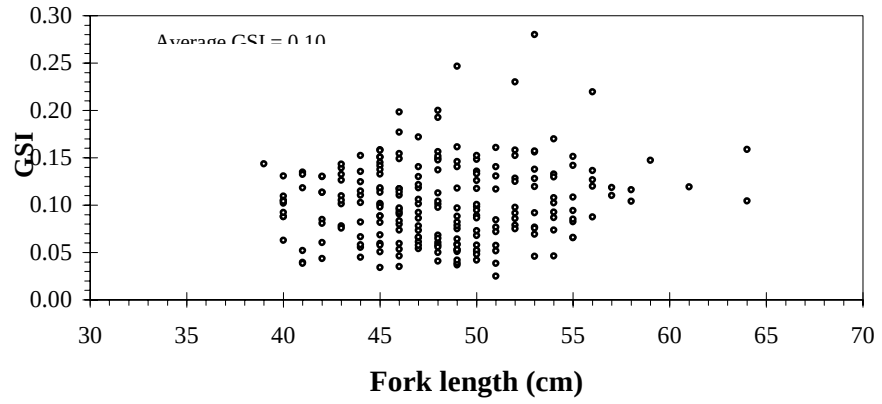
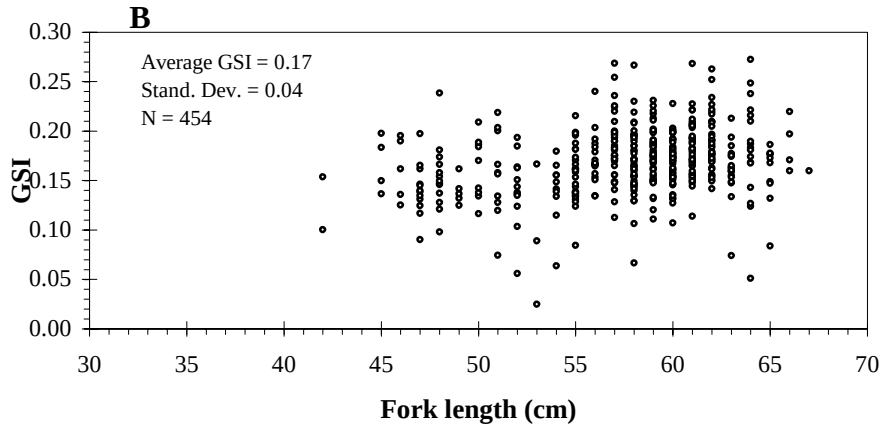


Figure 9. Trackline and haul locations with percent mature female pollock > 38 cm from the winter 2001 echo integration-trawl survey of the southeast Bering Sea shelf and Bogoslof Island areas. Transect numbers are underlined. Dash-dotted line indicates boundary of the sea lion Conservation Area (SCA), and the dashed line outlines U.S. management area 518/Central Bering Sea specific area.





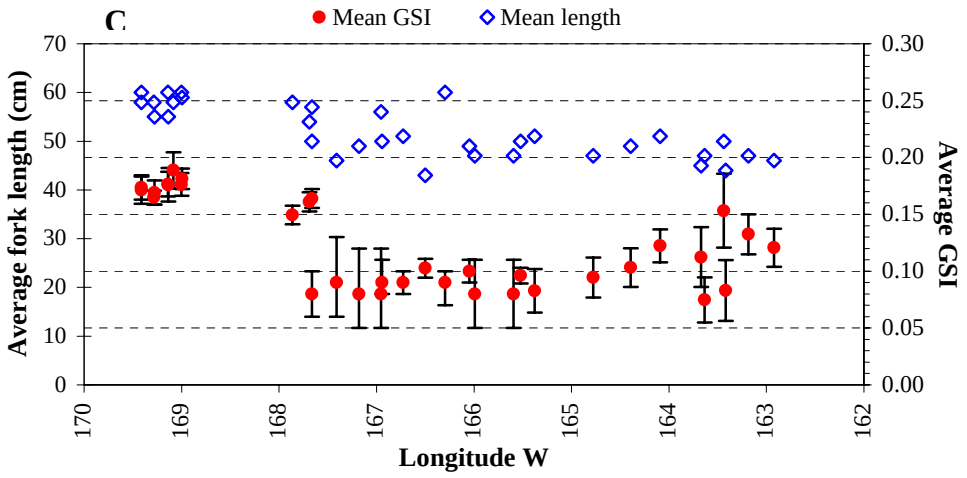


Figure 10. Pollock gonado-somatic indices (GSI) for mature females as a function of length from the winter 2001 echo integration-trawl survey of the southeastern Bering Sea shelf (A) and Bogoslof Island area (B). Average GSI with 95 % confidence intervals, and fork length averages as a function of longitude are depicted in C.

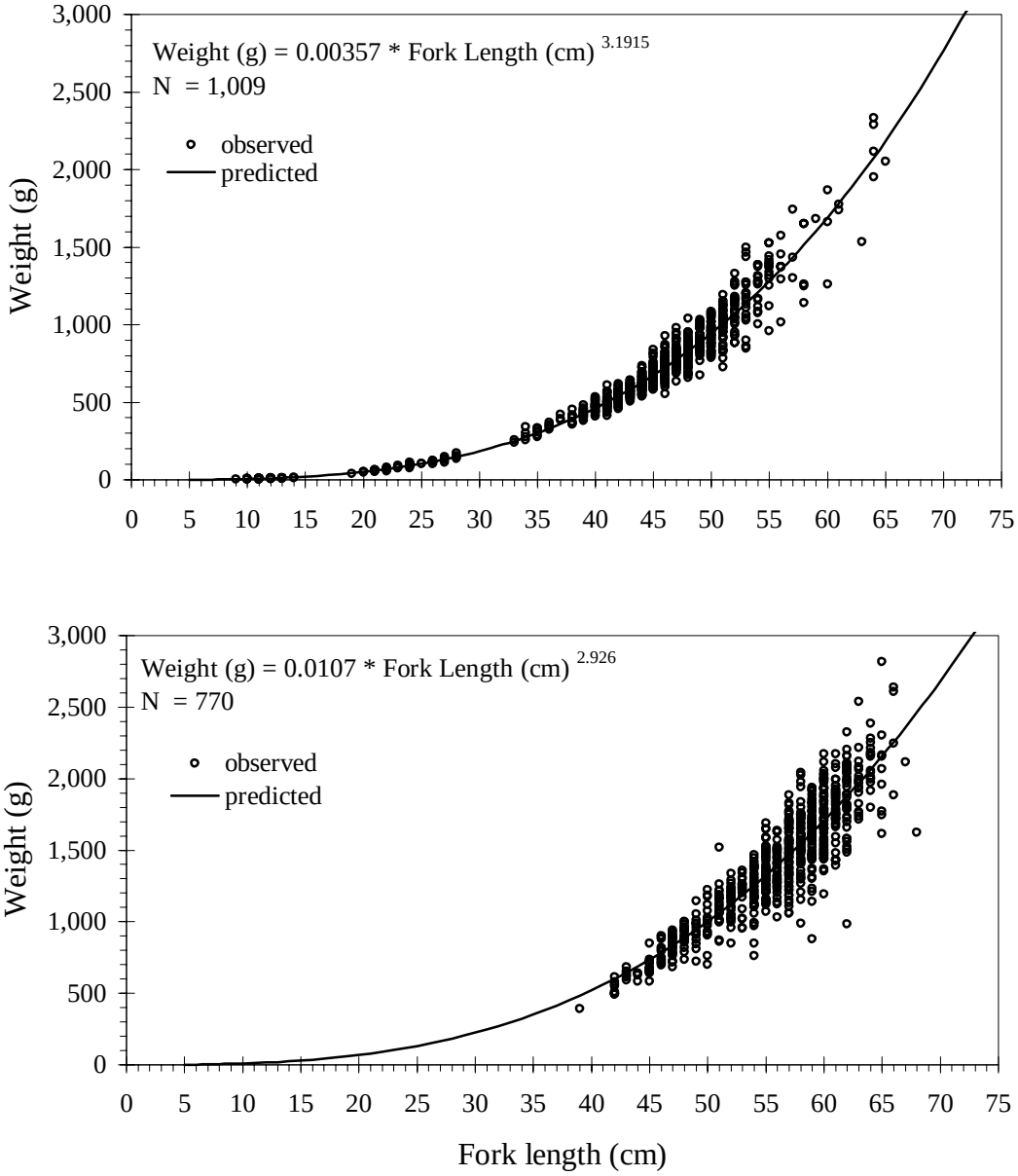


Figure 11. Pollock length-weight relationships observed during the winter 2001 echo integration-trawl survey of the southeastern Bering Sea shelf (upper), and Bogoslof Island region (lower).

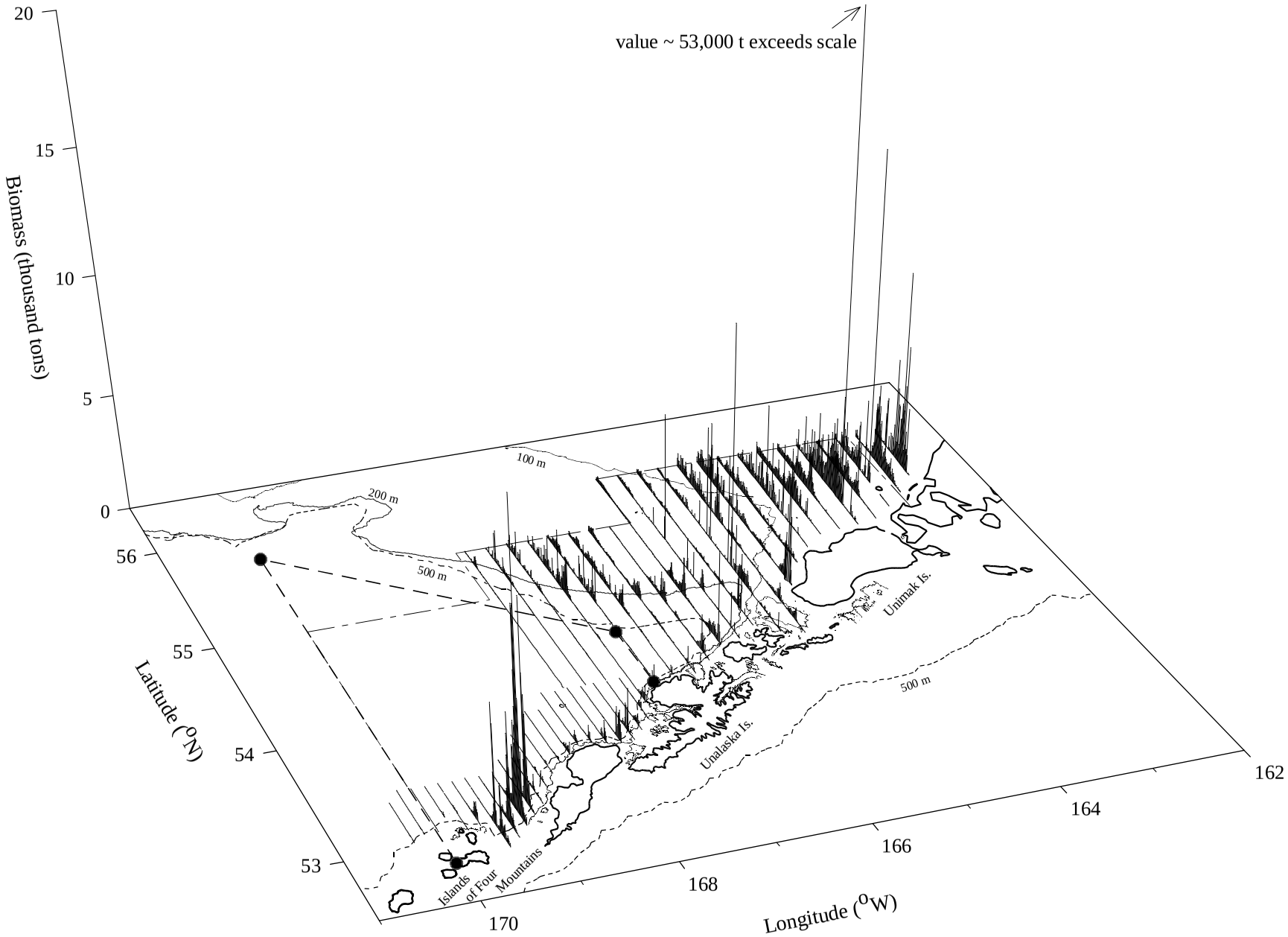


Figure 12. Pollock biomass (t) along tracklines from the winter 2001 echo integration-trawl survey of the southeast Bering Sea shelf and Bogoslof Island areas. Dash-dotted line indicates boundary of the sea lion Conservation Area (SCA), and long dashed line outlines U.S. management area 518/Central Bering Sea specific area.

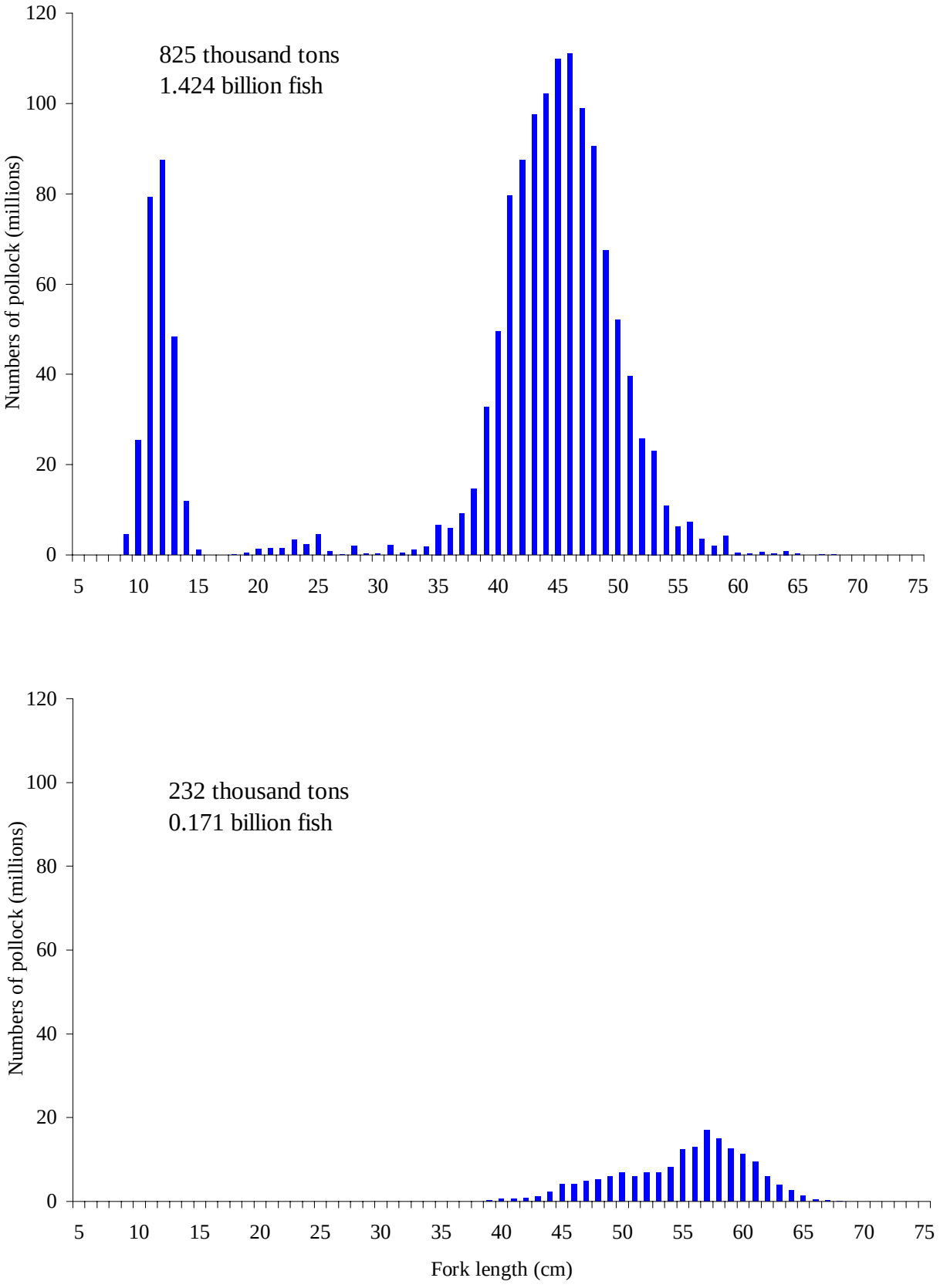


Figure 13. Estimated pollock numbers at length from the winter 2001 echo integration-trawl survey of the southeastern Bering Sea shelf (upper) and Bogoslof Island region (lower).

(lower).

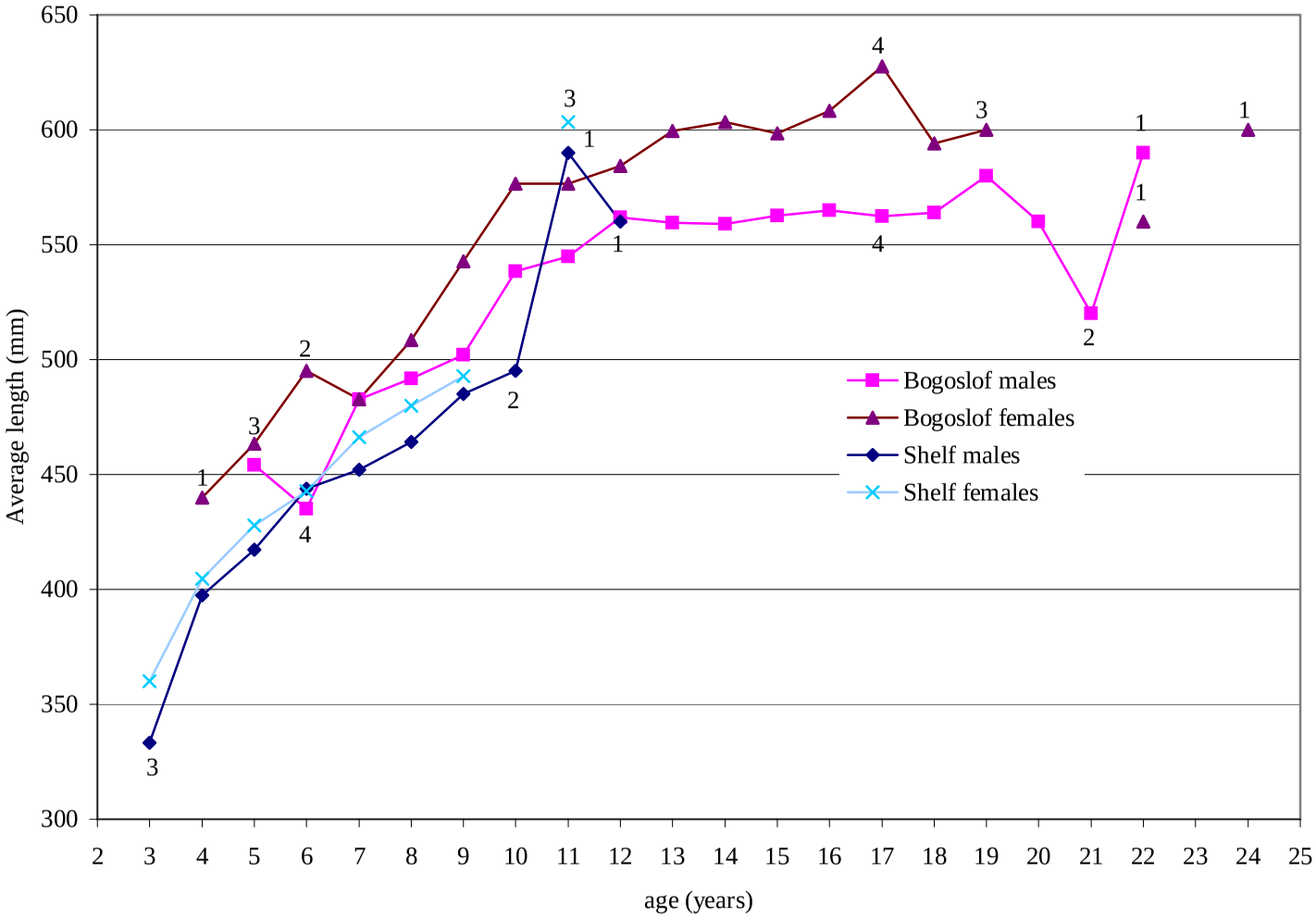


Figure 14. Average lengths at age for pollock from the winter 2000 echo integration-trawl survey of the Bering Sea shelf and Bogoslof Island area. Samples based on fewer than 5 individual pollock are indicated with sample numbers.

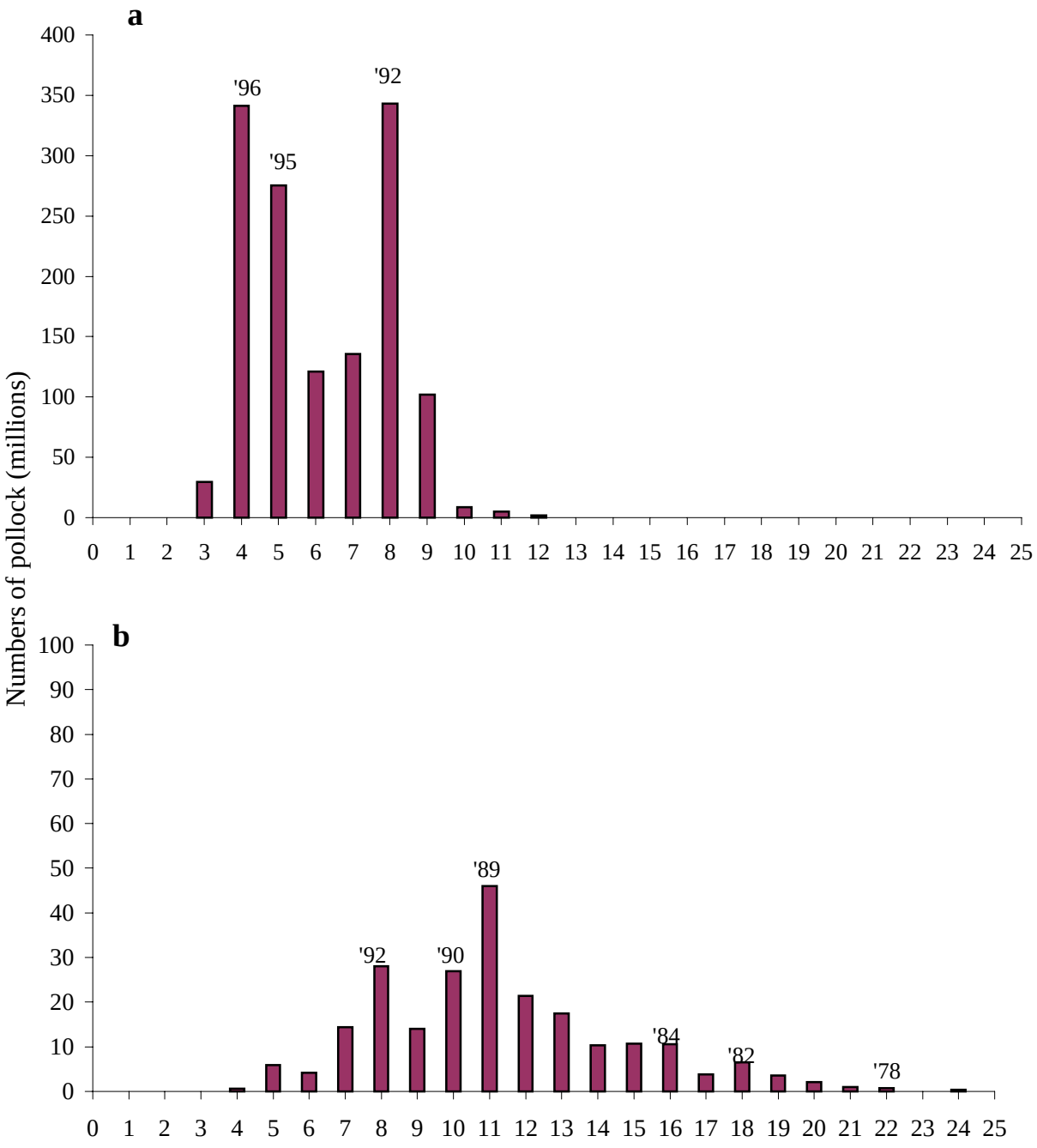


Figure 15. Estimated numbers of walleye pollock by age from the winter 2000 echo integration-trawl survey of the southeastern Bering Sea shelf (a) and Bogoslof Island area (b). Major year classes are indicated. Note Y-axis scales differ.

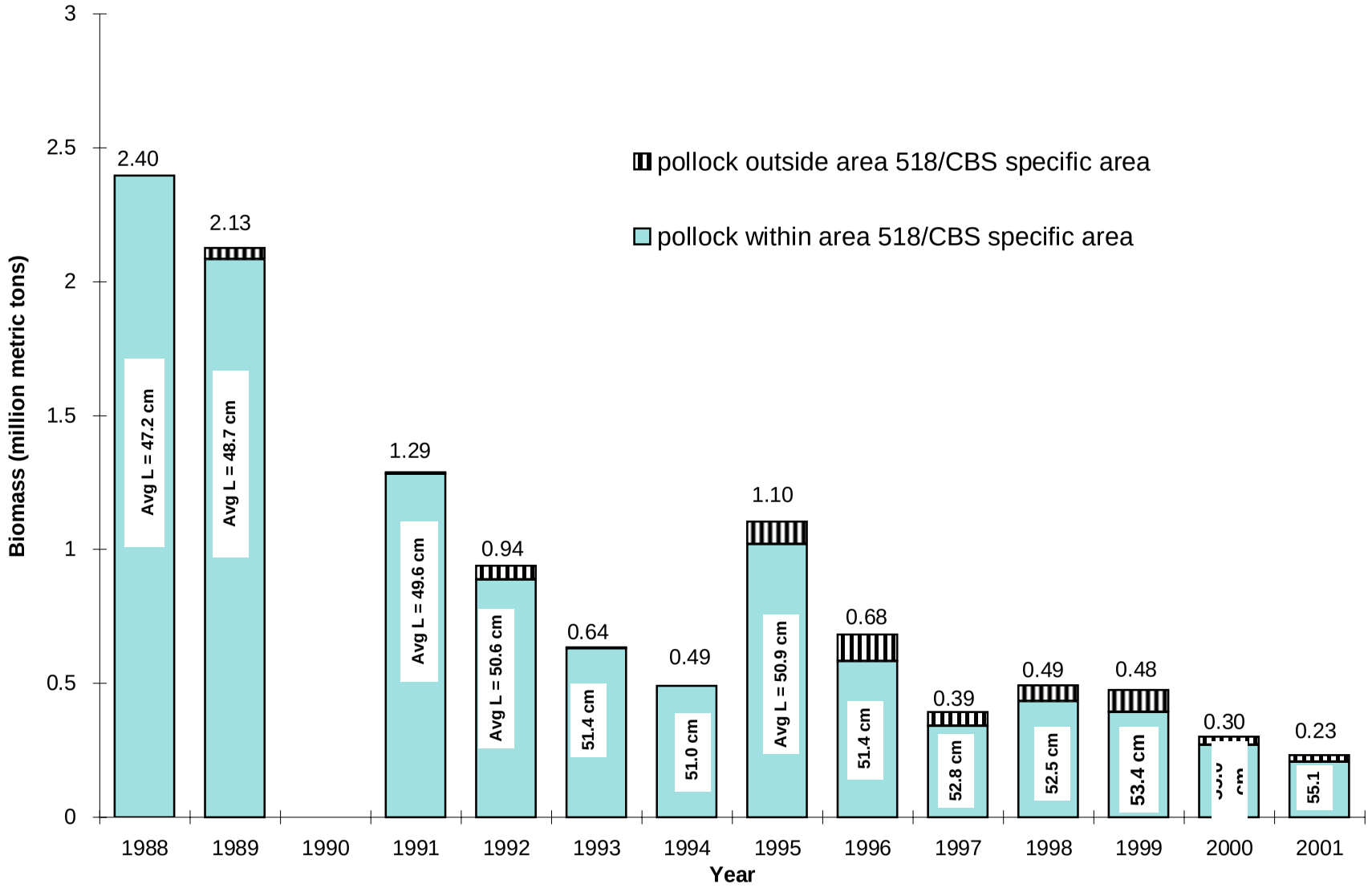


Figure 16. Biomass estimates and average fork lengths obtained during winter echo integration-trawl surveys for pre-spawning walleye pollock near Bogoslof Island, 1988-2001. The U.S. conducted all but the 1999 survey, which was conducted by Japan. There was no survey in 1990. Total pollock biomass for each survey year is indicated on top of each bar.

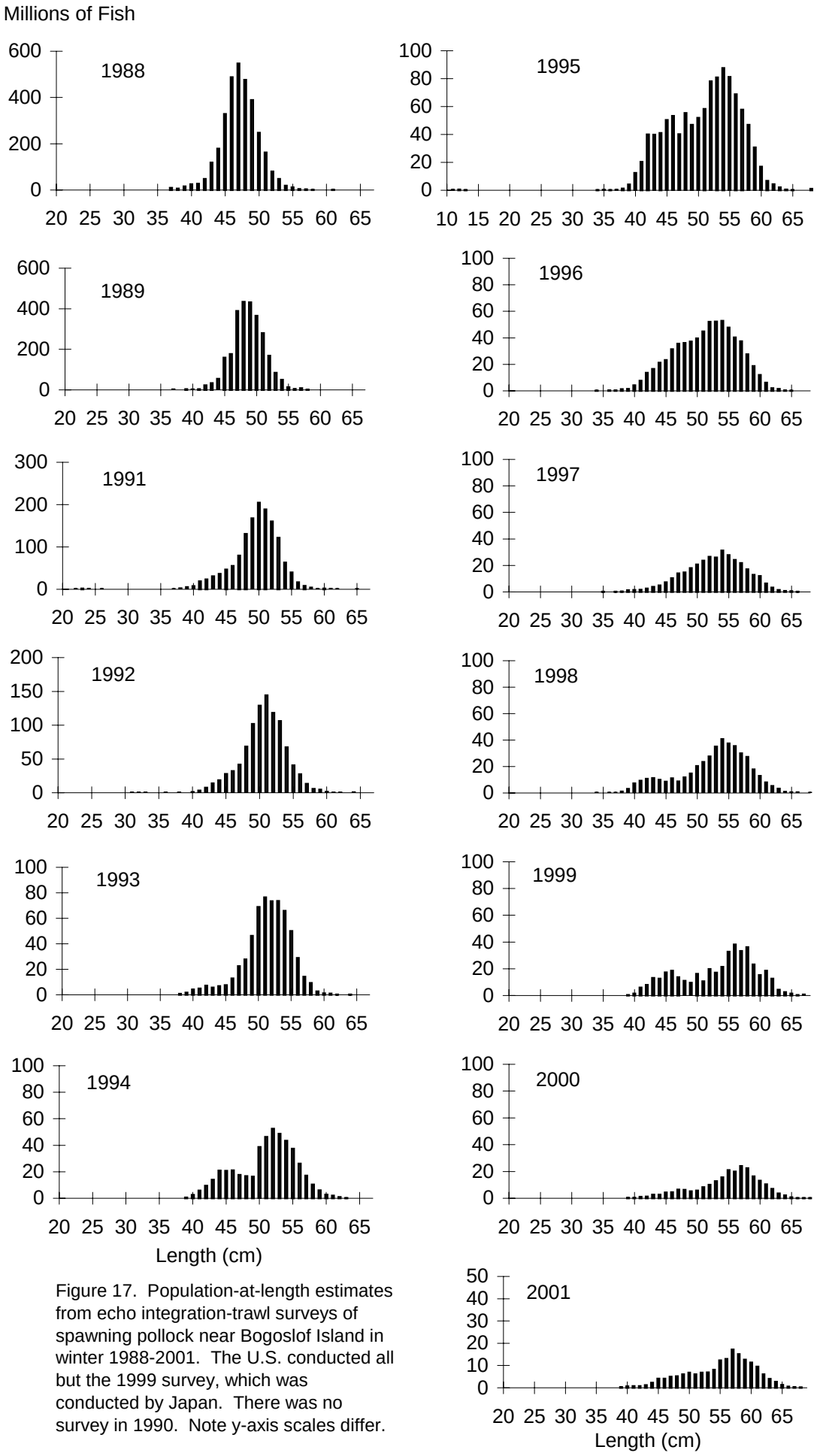


Figure 17. Population-at-length estimates from echo integration-trawl surveys of spawning pollock near Bogoslof Island in winter 1988-2001. The U.S. conducted all but the 1999 survey, which was conducted by Japan. There was no survey in 1990. Note y-axis scales differ.

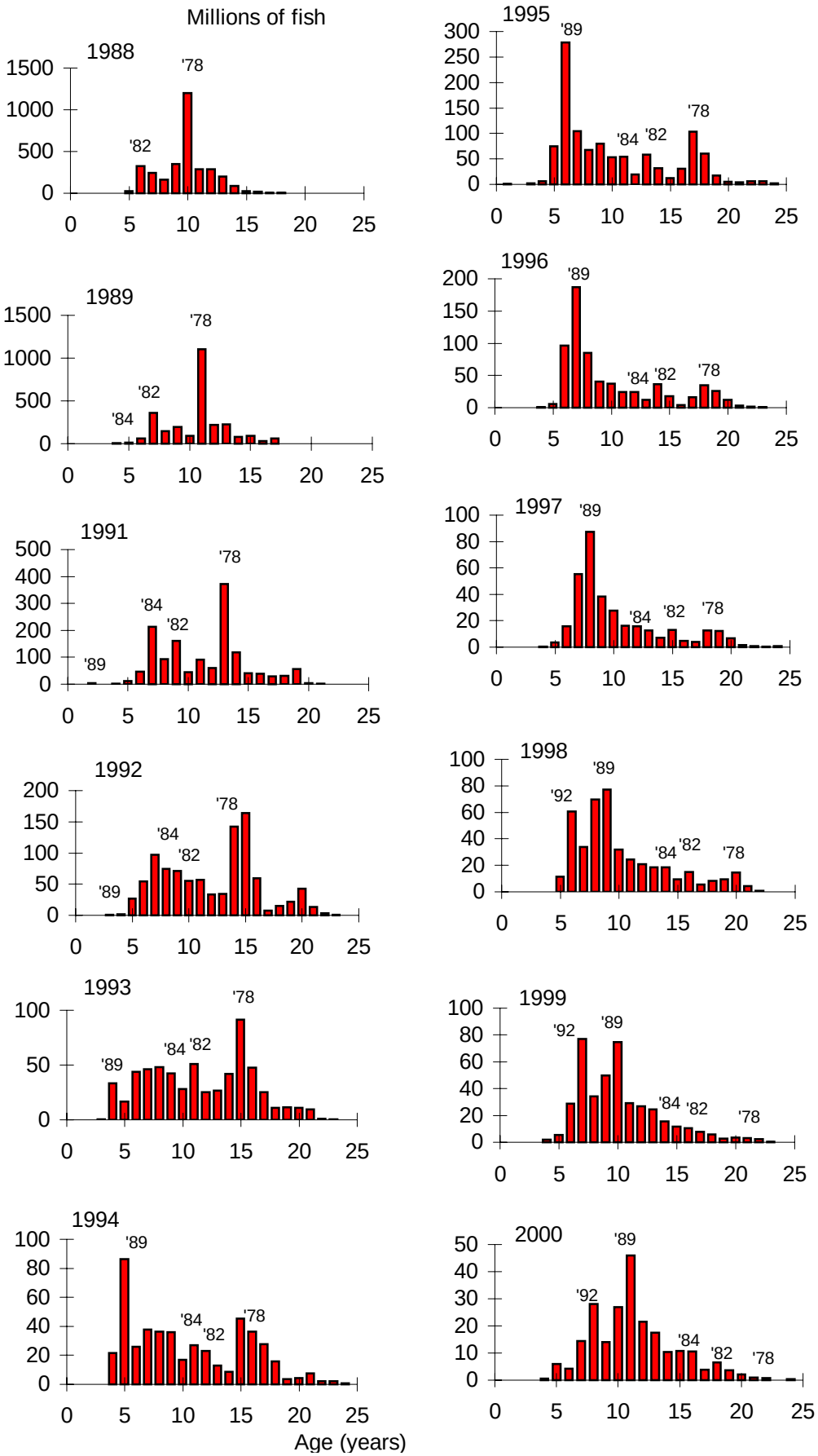


Figure 18. Population-at-age estimates obtained during echo integration-trawl surveys of walleye pollock near Bogoslof Island in winter 1988-2001. Major year classes are indicated. The U.S. conducted all but the 1999 survey, which was conducted by Japan. No survey was conducted in 1990. Ages are not yet available for 2001. Note y-axis scales differ.

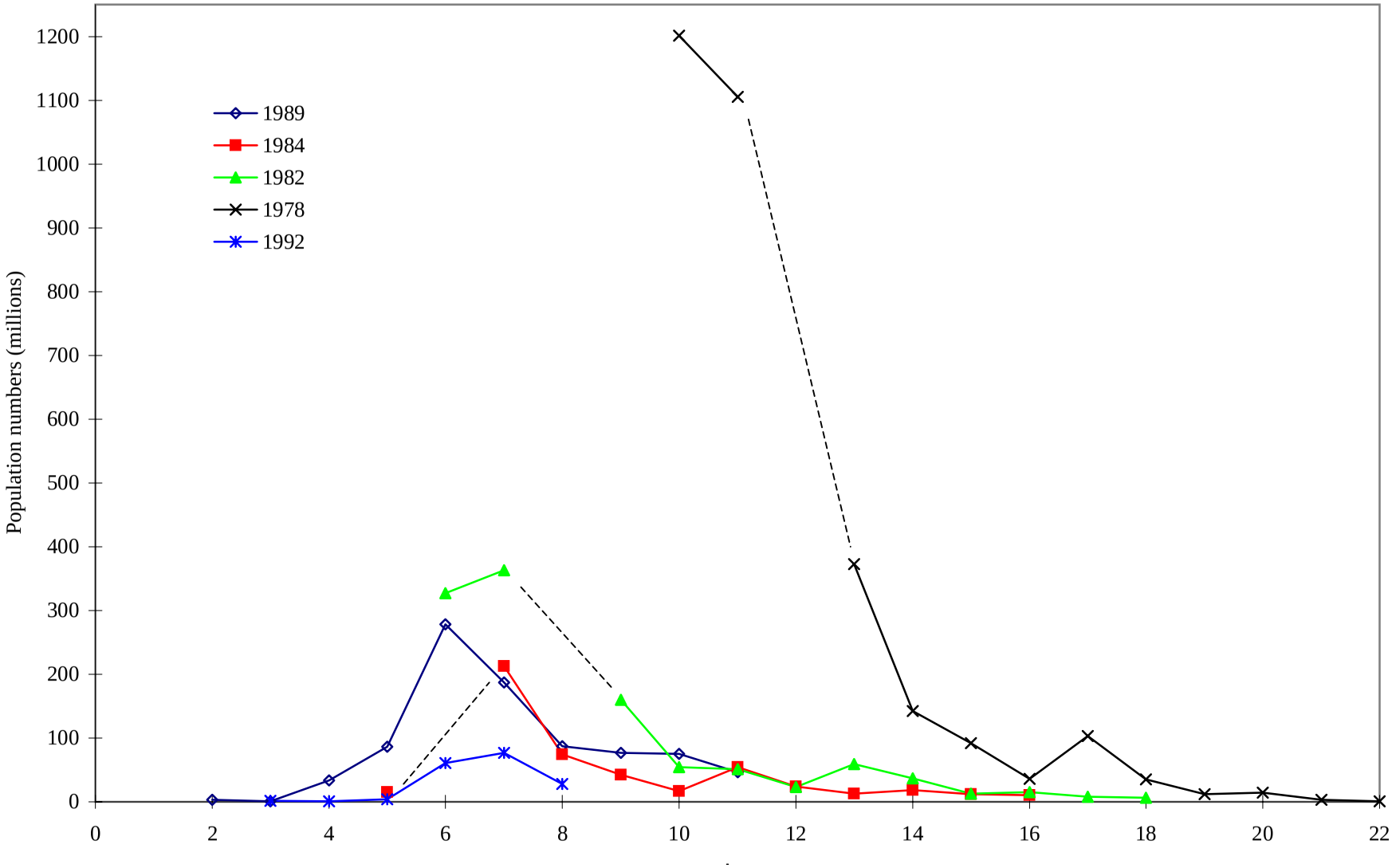


Figure 19. Population numbers at age for dominant year classes observed in winter echo integration-trawl surveys of Bogoslof area spawning pollock. Data are from surveys conducted in 1988-2000. The U.S. conducted all but the 1999 survey, which was conducted by Japan. No survey was conducted in 1990 (dashed lines).

Table 1. Summary of results of sphere calibrations conducted before, during, and after the winter 2001 pollock echo integration-trawl survey in the Bering Sea.

Date	Location	Frequency (kHz)	Water Temp (°C) at Transducer[1]	Water Temp (°C) at Sphere	Sphere Range from Transducer (m)	TS Gain (dB)	SV Gain (dB)	Along 3 dB Beam Width (deg)	Angle Offset Along	Angle Offset Athwart
22-Jan	Port Susan, WA	38	9.6	10.0	22.1	25.8	25.5	6.83	-0.11	0.02
		120	9.6	9.6	16.7	25.5	25.6	-	-	-
12-Feb	Captains Bay, AK	38	4.2	4.2	25.6	25.9	25.7	6.88	-0.08	0.00
		120	4.2	4.2	20.1	25.0	25.1	7.41	-0.24	0.34
5-Mar	Captains Bay, AK	38	3.8	4.0	25.0	25.9	25.7	6.86	-0.07	0.00
		120	3.8	4.0	19.6	24.9	24.9	7.28	-0.17	0.26
27-Mar	Malina Bay, AK	38	5.1	5.2	29.4	25.8	25.6	-	-	-
		120	5.1	5.2	23.9	25.0	25.1	-	-	-
Feb-Mar	System settings during surveys	38	-	-	-	25.8	25.5	6.90	-0.08	0.03
		120	-	-	-	25.3	25.4	7.10	-0.12	-0.21

SV threshold used for post-processing = -69 dB

[1]The transducer was located approximately 9 m below the water surface.

Note: Gain and beam pattern terms are defined in the "Operator Manual for Simrad EK500 Scientific Echo Sounder (1993)" available from Simrad Subsea A/S , Strandpromenaden 50, P.O. Box 111, N-3191 Horten, Norway.

Table 2. Trawl station and catch data summary from the winter 2001 echo integration-trawl survey of walleye pollock in the southeastern Bering Sea shelf and Bogoslof Island region.

Haul No.	Gear Type[1]	Date	Time (GMT)	Duration (minutes)	Start Position		Depth (m)		Temp. (deg. C)		Profiler No.[3]	Pollock Catch		Other Catch
					Latitude (N)	Longitude (W)	Gear	Bottom	Gear[2]	Surface		(kg)	number	(kg)
1	317	20 Feb	15:43	15	55 43.78	162 55.30	62	66	3.6	3.5	301	1,370.1	2,048	41.7
2	30	21 Feb	5:04	17	55 34.57	163 11.14	60	60	3.7	3.9	302	1,747.8	2,240	44.2
3	317	21 Feb	11:38	18	55 24.59	163 26.19	55	59	3.6	3.8	303	43.9	54	9.6
4	317	21 Feb	15:28	12	55 41.60	163 25.16	63	85	3.7	3.7	304	15.8	28	0.3
5	317	21 Feb	21:37	19	55 48.15	163 38.04	81	93	3.8	3.7	305	683.1	1,159	01.2
6	317	22 Feb	7:26	12	55 22.15	163 40.22	59	66	3.6	3.8	306	2,526.4	3,852	55.6
7	30	22 Feb	14:07	30	55 54.28	164 5.41	93	93	4.2	3.6	307	38.6	79	11.4
8	317	23 Feb	0:14	30	55 29.38	164 23.67	91	100	4.2	3.8	308	1,882.8	2,724	21.2
9	317	23 Feb	21:40	50	55 42.10	164 46.70	92	99	3.9	3.9	309	210.5	299	47.3
10	317	24 Feb	19:24	28	54 47.89	165 22.60	153	165	4.2	4	310	529.1	587	2.6
11	317	25 Feb	9:58	22	55 48.23	165 31.37	106	113	3.9	4	311	820.1	1,310	6.9
12	317	25 Feb	18:59	19	54 32.74	165 35.73	223	238	4	4.1	312	1,639.9	1,900	0.0
13	317	26 Feb	8:31	26	55 56.37	165 59.42	111	119	3.9	4	313	396.1	587	8.0
14	317	26 Feb	17:40	22	54 44.61	166 2.87	194	241	4.1	3.9	314	429.1	607	8.7
15	317	27 Feb	0:45	9	54 11.21	166 17.89	211	270	4.1	4.2	315	100.0	73	5.0
16	317	27 Feb	16:55	20	54 45.54	166 30.05	208	243	4.1	3.8	317	870.6	1,390	0.0
17	317	28 Feb	7:57	20	55 12.92	166 43.72	129	142	4.3	3.8	318	29.9	130	0.5
18	317	28 Feb	14:46	25	55 21.29	166 56.54	126	139	4.3	3.7	319	205.1	447	7.8
19	626	28 Feb	17:43	6	55 21.42	166 56.74	70	140	3.9	3.8	320	0.0	0	0.0
20	317	28 Feb	21:40	21	55 0.87	166 57.25	148	156	4.3	3.7	321	22.9	1,619	0.2
21	317	1 Mar	20:02	15	54 57.48	167 10.86	208	219	3.9	3.8	322	56.1	1,240	8.0
22	317	2 Mar	4:32	40	55 2.69	167 24.66	231	247	4	3.9	323	346.5	521	68.5
23	30	2 Mar	21:19	18	55 11.72	167 10.32	150	150	4.1	3.7	324	2,006.4	3,383	53.6
24	317	3 Mar	1:43	19	55 21.08	167 39.67	147	151	3.8	3.8	325	234.4	26,430	0.0
25	317	6 Mar	20:24	5	53 34.46	167 41.28	444	716	3.8	4.2	326	2,796.5	2,413	3.5

Haul No.	Gear Type[1]	Date	Time (GMT)	Duration (minutes)	Start Position				Depth (m)		Temp. (deg. C)		Profiler No.[3]	Pollock Catch		Other Catch
					Latitude (N)		Longitude (W)		Gear	Bottom	Gear[2]	Surface		(kg)	number	(kg)
26	317	6 Mar	22:18	4	53	34.23	167	39.81	463	614	3.7	4.2	327	4,938.5	3,825	1.5
27	317	7 Mar	6:45	36	53	34.63	167	51.82	412	659	3.9	4.7	328	165.9	101	20.6
28	317	8 Mar	8:41	2	53	12.92	168	59.79	464	779	3.8	4.7	329	1,663.6	1,126	2.4
29	317	8 Mar	11:03	4	53	10.50	169	0.05	435	703	3.7	4.7	330	475.0	282	3.4
30	317	9 Mar	4:14	7	53	5.18	169	24.80	458	930	3.8	4.6	331	1,351.3	827	1.2
31	317	9 Mar	8:08	9	53	5.43	169	24.78	511	901	3.6	4.3	332	316.8	217	9.1
32	317	9 Mar	10:54	18	53	5.47	169	16.74	490	1053	3.6	4.4	333	1,602.7	1,230	25.3
33	317	9 Mar	13:44	9	53	0.55	169	17.09	472	779	3.6	4.2	334	1,315.2	824	4.8
34	317	9 Mar	18:36	26	53	9.49	169	8.24	585	1082	3.5	4.4	335	359.6	294	18.8
35	317	10 Mar	2:47	15	53	9.80	169	5.04	428	953	3.8	4.5	336	949.0	645	5.3
36	317	10 Mar	5:12	11	53	5.00	169	8.36	437	590	3.8	4.7	337	377.2	225	3.1

[1] Gear type: 317 = Aleutian wing trawl, 30 = 83/112 bottom trawl, 626 = Methot trawl

[2] Gear temperature was measured at the trawl headrope depth.

[3] Three-hundred series = SeaBird SBE39

Table 3. Inventory (numbers of fish) of pollock biological samples and measurements collected during the winter 2001 echo integration-trawl survey in the southeastern Bering Sea shelf and Bogoslof region.

Haul	Length	Maturity	Otoliths	Fish Weight	Ovary Weight
1	322	51	51	51	19
2	399	55	55	55	17
3	54	26	26	26	13
4	28	28	28	28	11
5	373	68	68	68	7
6	455	53	53	53	11
7	79	61	61	61	16
8	353	40	40	40	12
9	299	34	34	34	13
10	324	43	43	43	6
11	426	40	40	40	5
12	296	41	41	41	6
13	347	51	51	51	12
14	311	35	35	35	6
15	73	21	21	21	10
16	378	38	38	38	6
17	120	47	47	47	6
18	294	60	60	60	17
20	68	6	6	6	2
21	106	56	36	56	12
22	337	57	57	57	7
23	345	38	38	38	15
24	99	11	11	11	0
25	376	87	87	87	47
26	365	78	78	78	42
27	101	19	19	19	16
28	341	49	49	49	49
29	282	60	60	60	51
30	299	73	73	73	39
31	217	76	76	76	30
32	423	73	73	73	24
33	336	69	69	69	55
34	265	66	66	66	17
35	394	78	78	78	37
36	225	42	42	42	34
Totals	9,510	1,730	1,710	1,730	670

Table 4. Inventory (numbers) of biological samples collected for other research projects during the winter 2001 pollock echo integration-trawl survey of the southeastern Bering Sea shelf and Bogoslof Island region.

	Pollock						Sea lion and seabird prey collection
	Ovary collection[1]					Genetics	
Haul	# 1	# 2	Stomachs	Spawning	Age 1[2]	Fin clip	
1	-	8	7	-	-	-	X[3]
2	-	8	15	-	-	-	-
3	-	1	15	-	-	-	-
4	-	6	1	-	-	-	-
5	23	2	6	-	-	-	X
6	-	1	15	-	-	-	X
7	-	5	-	-	-	-	-
8	21	1	4	-	-	-	X
9	12	2	-	-	-	-	X
10	5	-	3	-	-	100	X
11	-	1	1	-	-	-	X
12	7	-	-	-	-	100	-
13	-	1	17	-	-	100	X
14	3	-	-	-	-	-	X
15	11	1	10	-	-	-	X
16	1	3	-	-	-	-	-
17	-	-	15	-	-	-	X
18	-	2	5	-	-	-	X
20	-	-	15	-	X	-	X
21	-	-	15	-	-	-	X
22	-	-	15	-	-	-	X
23	-	-	-	-	-	-	-
24	-	-	15	-	X	-	X
25	17	22	-	-	-	-	X
26	12	6	-	-	-	78	-
27	-	2	-	-	-	101	X
28	-	-	-	-	-	-	-
29	-	-	-	-	-	-	X
30	14	-	-	-	-	73	-
31	-	2	-	X	-	100	X
32	-	-	-	-	-	-	X
33	-	-	-	-	-	-	X
34	-	-	-	-	-	-	X
35	30	-	-	X	-	-	X
36	-	-	-	-	-	-	X
Total	156	74	174	2 sites	2 sites	652	25 sites

[1] Pollock ovaries were collected for

1: DNA stock structure and fecundity studies by Korean scientists,

2: fecundity study by NMFS scientists

[2] Pollock age 1 were collected for M. Wilson and K. Bailey, NMFS scientists

[3] "X" indicates a collection was made, but numbers were not specified.

Table 5. Catch by species from 19 Aleutian Wing trawl hauls conducted during the winter 2001 walleye pollock echo integration-trawl survey of the southeastern Bering Sea shelf.

Species Name	Scientific Name	Weight (kg)	Percent	Numbers
walleye pollock	*Theragra chalcogramma*	12,312.5	92.6	46,932
chrysaora jellyfish	*Chrysaora sp.*	693.8	5.2	4
jellyfish unident.	*Scyphozoa (class)*	150.9	1.1	19
Pacific sleeper shark	*Somniosus pacificus*	62.0	0.5	1
chinook salmon	*Oncorhynchus tshawytscha*	25.6	0.2	14
smooth lumpsucker	*Aptocyclus ventricosus*	16.8	0.1	7
Pacific cod	*Gadus macrocephalus*	15.4	0.1	4
rock sole sp.	*Lepidopsetta sp.*	11.9	0.1	36
flathead sole	*Hippoglossoides elassodon*	4.0	0.0	18
eulachon	*Thaleichthys pacificus*	2.6	0.0	82
arrowtooth flounder	*Atheresthes stomias*	2.2	0.0	2
yellowfin sole	*Limanda aspera*	1.5	0.0	7
sturgeon poacher	*Podothecus acipenserinus*	0.9	0.0	11
squid unident.		0.5	0.0	130
crescent-tail sculpin	*Triglops metopias*	0.2	0.0	1
shrimp unident.		0.0	0.0	3
capelin	*Mallotus villosus*	0.0	0.0	1
Totals		13,300.8		47,272

Table 6. Catch by species from 3 bottom trawl hauls conducted during the winter 2001 walleye pollock echo integration-trawl survey of the southeastern Bering Sea shelf.

Species Name	Scientific Name	Weight (kg)	Percent	Numbers
walleye pollock	*Theragra chalcogramma*	3,792.8	55.8	5,702
rock sole sp.	*Lepidopsetta sp.*	1,361.7	20.0	5,065
invertebrate unident.		716.8	10.5	98
arrowtooth flounder	*Atheresthes stomias*	240.5	3.5	524
Pacific cod	*Gadus macrocephalus*	147.8	2.2	161
yellowfin sole	*Limanda aspera*	126.0	1.9	539
Pacific halibut	*Hippoglossus stenolepis*	85.6	1.3	43
flathead sole	*Hippoglossoides elassodon*	75.7	1.1	342
starfish unident.	*Asteroidea unident.*	61.0	0.9	490
Alaska skate	*Bathyraja parmifera*	53.6	0.8	11
hermit crab unident.	*Paguridae*	30.3	0.4	342
Tanner crab	*Chionoecetes bairdi*	22.6	0.3	168
jellyfish unident.	*Scyphozoa (class)*	14.5	0.2	
rex sole	*Glyptocephalus zachirus*	13.4	0.2	95
snow crab	*Chionoecetes opilio*	12.6	0.2	44
	Neptunea sp.	12.1	0.2	96
red king crab	*Paralithodes camtschaticus*	8.2	0.1	3
unsorted shab		6.4	0.1	
Oregon triton	*Fusitriton oregonensis*	5.0	0.1	69
flatfish unident.	*Pleuronectiformes*	3.3	0.0	10
sturgeon poacher	*Podothecus acipenserinus*	3.0	0.0	28
Alaska plaice	*Pleuronectes quadrituberculatus*	2.4	0.0	6
sponge unident.	*Porifera*	2.4	0.0	
sablefish	*Anoplopoma fimbria*	1.8	0.0	8
eulachon	*Thaleichthys pacificus*	1.1	0.0	28
sea anemone unident.	*Actiniaria (order)*	0.6	0.0	53
	Buccinum sp.	0.5	0.0	9
	Hyas sp.	0.1	0.0	3
Oregon rock crab	*Cancer oregonensis*	0.0	0.0	8
shrimp unident.		0.0	0.0	5
Totals		6,802.0		13,950

Table 7. Catch by species from 13 Aleutian Wing trawl hauls conducted during the winter 2001 walleye pollock echo integration-trawl survey in the Bogoslof region.

Species Name	Scientific Name	Weight (kg)	Percent	Numbers
walleye pollock	*Theragra chalcogramma*	12,312.5	92.6	46,932
chrysaora jellyfish	*Chrysaora sp.*	693.8	5.2	4
jellyfish unident.	*Scyphozoa (class)*	150.9	1.1	19
Pacific sleeper shark	*Somniosus pacificus*	62.0	0.5	1
chinook salmon	*Oncorhynchus tshawytscha*	25.6	0.2	14
smooth lumpsucker	*Aptocyclus ventricosus*	16.8	0.1	7
Pacific cod	*Gadus macrocephalus*	15.4	0.1	4
rock sole sp.	*Lepidopsetta sp.*	11.9	0.1	36
flathead sole	*Hippoglossoides elassodon*	4.0	0.0	18
eulachon	*Thaleichthys pacificus*	2.6	0.0	82
arrowtooth flounder	*Atheresthes stomias*	2.2	0.0	2
yellowfin sole	*Limanda aspera*	1.5	0.0	7
sturgeon poacher	*Podothecus acipenserinus*	0.9	0.0	11
squid unident.		0.5	0.0	130
crescent-tail sculpin	*Triglops metopias*	0.2	0.0	1
shrimp unident.		0.0	0.0	3
capelin	*Mallotus villosus*	0.0	0.0	1
Totals		13,300.8		47,272

Table 8. Estimates of pollock biomass in the entire Bogoslof Island region and inside the Central Bering Sea specific area[1] (U.S. fisheries management area 518) from echo integration-trawl surveys between 1988-2001. No survey was conducted in 1990.

	Entire Bogoslof Survey Area			Biomass estimate bounds (million t)		CBS specific area/ U.S. area 518			
Year	Biomass* (million t)	Acoustic Return (Sm)	95% CI's (+-%)	lower	upper	Biomass inside	Biomass outside	Proportion inside	Proportion outside
1988	2.396	--	--	--	--	2.396	0.000	1.00	0.00
1989	2.126	--	--	--	--	2.084	0.042	0.98	0.02
1990	--	--	--	--	--	--	--	--	--
1991	1.289	11063	23.3	0.989	1.589	1.283	0.006	1.00	0.00
1992	0.940	7914	40.8	0.557	1.324	0.888	0.052	0.94	0.06
1993	0.635	5134	18.4	0.518	0.752	0.631	0.005	0.99	0.01
1994	0.490	3020	23.2	0.376	0.604	0.490	0.000	1.00	0.00
1995	1.104	8236	21.4	0.868	1.340	1.020	0.084	0.92	0.08
1996	0.682	5604	39.2	0.415	0.950	0.582	0.100	0.85	0.15
1997	0.392	2985	28.0	0.283	0.502	0.342	0.051	0.87	0.13
1998	0.492	3829	38.0	0.305	0.680	0.432	0.060	0.88	0.12
1999	0.475	--	--	--	--	0.393	0.083	0.83	0.17
2000	0.301	2200	28.5	0.215	0.387	0.270	0.032	0.90	0.10
2001	0.232	1654	20.0	0.185	0.278	0.208	0.024	0.90	0.10

* The 1999 survey was conducted by Japan Fisheries Agency

$Sm = \sum_{1}^{n} Sa * A_n /1000$, where n is the number of 0.5 nmi intervals along the transect, Sa is meters^2 of pollock backscattering per nmi^2 and $A_n = 0.5 * w$, where w is the width assigned to the interval and varies depending on transect spacing.

[1]The "specific area" is defined in the Annex to the Convention on the Conservation and Management of Pollock Resources in the Central Bering Sea as "the area south of a straight line between a point at 55° 46' N lat. and 170° W long. and a point at 54° 30' N lat., 167° W long. and between the meridian 167° W long. and the meridian 170° W long. and the north of the Aleutian Islands and straight lines between the islands connecting the following coordinates in the order listed: 52° 49.2 N 169° 40.4 W, 52° 49.8 N 169° 06.3 W, 53° 23.8 N 167° 50.1 W, 53° 18.7 N 167° 51.4 W.

Table 9. Estimates of population at length (millions of fish) from February-March echo integration-trawl surveys* of pre-spawning pollock in the Bogoslof Island area. No survey was conducted in 1990.

Length	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
10	0	0	--	0	0	0	0	<1	0	0	0	0	0	0
11	0	0	--	0	0	0	0	<1	0	0	0	0	0	0
12	0	0	--	0	0	0	0	1	0	0	0	0	0	0
13	0	0	--	0	0	0	0	<1	0	0	0	0	0	0
14	0	0	--	0	0	0	0	<1	0	0	0	0	0	0
15	0	0	--	0	0	0	0	0	0	0	0	0	0	0
16	0	0	--	0	0	0	0	0	0	0	0	0	0	0
17	0	0	--	0	0	0	0	0	0	0	0	0	0	0
18	0	0	--	0	0	0	0	0	0	0	0	0	0	0
19	0	0	--	0	0	0	0	0	0	0	0	0	0	0
20	0	0	--	0	0	0	0	0	0	0	0	0	0	0
21	0	0	--	0	0	0	0	0	0	0	0	0	0	0
22	0	0	--	<1	0	0	0	0	0	0	0	0	0	0
23	0	0	--	2	0	0	0	0	0	0	0	0	0	0
24	0	0	--	1	0	0	0	0	0	0	0	0	0	0
25	0	0	--	0	0	0	0	0	0	0	0	0	0	0
26	0	0	--	<1	0	0	0	0	0	0	0	0	0	0
27	0	0	--	0	0	0	0	0	0	0	0	0	0	0
28	0	0	--	0	0	0	0	0	0	0	0	0	0	0
29	0	0	--	0	0	0	0	0	0	0	0	0	0	0
30	0	0	--	0	0	0	0	0	0	0	0	0	0	0
31	0	0	--	0	<1	0	0	0	0	0	0	0	0	0
32	0	0	--	0	<1	0	0	0	0	0	0	0	0	0
33	0	0	--	0	<1	0	0	0	0	0	0	0	0	0
34	0	0	--	0	0	0	0	<1	<1	0	<1	0	0	0
35	0	0	--	0	0	0	0	<1	0	<1	0	0	0	0
36	0	0	--	0	<1	0	0	<1	<1	<1	<1	0	0	0
37	9	3	--	<1	0	0	0	<1	<1	<1	<1	0	0	0
38	6	0	--	2	<1	1	0	1	1	<1	1	0	0	<1
39	16	4	--	5	0	2	<1	4	1	1	3	<1	<1	<1
40	24	3	--	7	1	4	3	12	4	1	7	1	<1	1
41	27	4	--	19	3	5	6	20	8	2	9	6	1	1
42	48	23	--	23	7	7	9	40	14	3	11	8	1	1
43	118	33	--	31	14	6	14	40	17	4	11	13	3	1
44	179	54	--	36	18	7	21	41	21	5	10	13	3	2
45	329	159	--	46	28	8	21	50	23	7	9	17	4	4
46	488	177	--	55	32	13	21	53	31	10	11	19	5	4
47	547	389	--	79	42	22	18	40	36	14	9	14	6	5
48	476	434	--	130	68	28	17	55	36	15	12	11	6	5
49	389	431	--	168	102	46	16	47	37	18	15	10	5	6
50	248	366	--	205	129	69	39	52	40	21	20	16	6	7
51	162	279	--	189	144	76	46	58	45	24	23	11	8	6
52	80	168	--	160	118	73	52	78	52	26	28	20	10	7

Table 9. continued.

Length	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001

53	48	85	--	122	106	73	49	81	52	26	35	17	13	7
54	19	50	--	63	67	66	43	88	53	31	41	21	16	8
55	12	13	--	40	41	50	37	81	48	28	38	33	21	12
56	4	5	--	17	27	29	26	69	40	24	35	38	20	13
57	3	8	--	8	13	14	17	58	37	22	30	33	24	17
58	1	1	--	4	6	9	10	47	28	17	27	36	23	15
59	0	0	--	1	5	3	6	31	19	13	18	23	16	13
60	0	0	--	1	1	1	3	17	12	12	13	15	13	11
61	2	0	--	1	<1	1	2	7	6	6	8	18	10	9
62	0	0	--	<1	<1	<1	1	4	2	3	5	13	7	6
63	0	0	--	0	0	0	<1	2	1	1	3	4	4	4
64	0	0	--	0	1	<1	0	1	<1	1	1	3	2	3
65	0	0	--	<1	0	0	0	<1	<1	<1	1	1	1	1
66	0	0	--	0	0	0	0	<1	0	<1	1	<1	<1	1
67	0	0	--	0	0	0	0	0	0	0	0	1	<1	<1
68	0	0	--	0	0	0	0	1	0	0	<1	0	<1	<1
69														<1
70														<1
Totals	3236	2687	--	1419	975	613	478	1081	666	337	435	416	229	171

* Echo integration-trawl surveys were conducted in 1988-1998, 2000-2001 by the Alaska Fisheries Science Center, Seattle, USA. The 1999 survey was conducted by Japan Fisheries Agency.

Table 10. Estimates of biomass at length (metric tons) from February-March echo integration-trawl surveys* of pre-spawning pollock in the Bogoslof Island area. No survey was conducted in 1990.

Length	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
10	0	0	--	0	0	0	0	<1	0	0	0	0	0	0
11	0	0	--	0	0	0	0	2	0	0	0	0	0	0
12	0	0	--	0	0	0	0	5	0	0	0	0	0	0
13	0	0	--	0	0	0	0	2	0	0	0	0	0	0
14	0	0	--	0	0	0	0	1	0	0	0	0	0	0
15	0	0	--	0	0	0	0	0	0	0	0	0	0	0
16	0	0	--	0	0	0	0	0	0	0	0	0	0	0
17	0	0	--	0	0	0	0	0	0	0	0	0	0	0
18	0	0	--	0	0	0	0	0	0	0	0	0	0	0
19	0	0	--	0	0	0	0	0	0	0	0	0	0	0
20	0	0	--	0	0	0	0	0	0	0	0	0	0	0
21	0	0	--	0	0	0	0	0	0	0	0	0	0	0
22	0	0	--	13	0	0	0	0	0	0	0	0	0	0
23	0	0	--	70	0	0	0	0	0	0	0	0	0	0
24	0	0	--	61	0	0	0	0	0	0	0	0	0	0
25	0	0	--	0	0	0	0	0	0	0	0	0	0	0
26	0	0	--	26	0	0	0	0	0	0	0	0	0	0
27	0	0	--	0	0	0	0	0	0	0	0	0	0	0
28	0	0	--	0	0	0	0	0	0	0	0	0	0	0
29	0	0	--	0	0	0	0	0	0	0	0	0	0	0
30	0	0	--	0	0	0	0	0	0	0	0	0	0	0
31	0	0	--	0	37	0	0	0	0	0	0	0	0	0
32	0	0	--	0	42	0	0	0	0	0	0	0	0	0
33	0	0	--	0	48	0	0	0	0	0	0	0	0	0
34	0	0	--	0	0	0	0	53	35	0	29	0	0	0
35	0	0	--	0	0	0	0	93	0	29	0	0	0	0
36	0	0	--	0	68	0	0	42	96	18	32	0	0	0
37	3199	846	--	115	0	0	0	113	109	84	92	0	0	0
38	2304	0	--	768	84	260	0	435	465	173	395	0	0	19
39	6365	1461	--	1843	0	634	202	1697	562	507	1250	258	168	149
40	10573	1116	--	2801	451	1776	1190	5510	1857	634	3208	1242	195	315
41	12697	1532	--	7940	1235	2276	2855	9777	3637	851	4484	5598	575	403

Table 10. continued

Length	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
42	24360	10704	--	10812	3316	3571	4990	20730	7012	1387	5652	7223	674	464
43	64253	16516	--	15540	6760	3089	8021	22332	9190	2158	6407	12079	1511	770
44	104733	29588	--	20103	9877	4006	12963	24863	12735	3018	6048	11877	1622	1562
45	206586	93899	--	28059	16329	4818	13823	32817	14927	4824	5592	16278	2848	2966
46	328735	113092	--	36235	20645	8835	15081	37303	21637	7399	7774	17678	3289	3218
47	394741	268496	--	56880	29146	16669	13565	30184	26425	10786	6653	13933	5002	4095
48	367368	323170	--	101488	51983	22214	13658	44572	28658	12233	9528	11280	5191	4548
49	320630	345632	--	141399	84329	39811	14414	40477	31599	15951	12766	10698	4659	5654
50	217890	314778	--	187006	115614	63571	36256	47785	35907	19593	18837	18373	5466	6794
51	152084	258067	--	186358	140004	75524	46297	57291	43272	23896	23203	12204	8364	6361
52	79654	166322	--	170855	124034	77721	55851	81793	53696	28549	29109	23427	10816	7605
53	50739	89721	--	139671	120309	83189	55151	90342	57294	29783	39234	20486	14509	8203
54	21211	56681	--	77905	82110	79461	52329	104021	61504	38168	48567	25270	19059	10064
55	14191	16270	--	52506	53286	64342	47770	102318	59033	35853	47461	39463	27179	16246
56	5580	6059	--	23541	38564	39556	35451	91962	52765	33144	47627	46764	27212	17977
57	3886	10681	--	12470	19710	20781	24453	81885	52000	31736	42594	40641	34562	24987
58	1395	1220	--	6603	9188	14391	15826	70522	40581	26309	41160	44788	34255	23153
59	0	0	--	1284	7872	4376	9546	48878	28918	21031	28241	28362	26252	20390
60	0	0	--	2743	2631	1989	4716	28240	19749	20509	21604	18174	22075	19263
61	2561	0	--	2195	562	1756	3644	11855	10762	11428	14301	22618	18519	16883
62	0	0	--	780	600	372	1826	7951	3578	6439	9748	15120	12972	11334
63	0	0	--	0	0	0	200	3978	2835	2999	6344	5181	7033	7722
64	0	0	--	0	1363	415	0	1074	863	1489	1777	3198	4277	5489
65	0	0	--	938	0	0	0	495	578	1096	1156	1833	1660	2730
66	0	0	--	0	0	0	0	163	0	329	1251	403	534	1132
67	0	0	--	0	0	0	0	0	0	0	0	863	520	715
68	0	0	--	0	0	0	0	2570	0	0	276	0	403	426
69	0	0	--	0	0	0	0	0	0	0	0	0	0	55
70	0	0	--	0	0	0	0	0	0	0	0	0	0	100
Totals	2395735	2125851	--	1289008	940197	635403	490078	1104118	682279	392403	492398	475311	310402	231795

* Echo integration-trawl surveys in 1988-1998 and 2000-01 were conducted by the Alaska Fisheries Science Center, Seattle, USA. The 1999 survey was conducted by Japan Fisheries Agency.

Table 11. Estimates of population at age (millions of fish) from February-March echo integration-trawl surveys* of pre-spawning pollock near Bogoslof Island. No survey was conducted in 1990.

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0	0	--	0	0	0	0	0	0	0	0	0	0
1	0	0	--	0	0	0	0	1	0	0	0	0	0
2	0	0	--	4	0	0	0	0	0	0	0	0	0
3	0	0	--	0	1	1	0	2	0	0	0	0	0
4	0	6	--	2	2	33	21	6	<1	<1	<1	2	1
5	28	15	--	12	27	17	86	75	6	4	11	5	6
6	327	58	--	46	54	44	26	278	96	16	61	29	4
7	247	363	--	213	97	46	38	105	187	55	34	77	14
8	164	147	--	93	74	48	36	68	85	88	70	34	28
9	350	194	--	160	71	42	36	80	40	38	77	50	14
10	1201	91	--	44	55	28	17	53	37	28	32	75	27
11	288	1105	--	92	57	51	27	54	24	16	25	29	46
12	287	222	--	60	33	25	23	19	24	16	21	27	21
13	202	223	--	373	34	27	13	59	12	13	19	25	17
14	89	82	--	119	142	42	9	32	36	7	18	16	10
15	27	90	--	41	164	92	45	12	18	13	9	12	11
16	17	30	--	38	59	47	36	31	4	5	15	10	11
17	7	60	--	29	8	25	28	103	16	4	5	8	4
18	3	0	--	32	15	11	16	60	35	12	8	6	6
19	0	0	--	56	22	11	4	18	26	12	10	3	4
20	0	0	--	4	42	11	4	5	12	7	15	4	2
21	0	0	--	2	13	10	8	5	3	2	4	3	1
22	0	0	--	0	3	1	2	6	2	1	1	2	1
23	0	0	--	0	1	1	2	6	1	<1	0	<1	0
24	0	0	--	0	0	0	1	2	0	1	0	0	<1
25	0	0	--	0	0	0	0	0	0	0	0	0	0
Totals	3236	2687	--	1419	975	613	478	1081	666	336	435	416	229

* Echo integration-trawl surveys in 1988-1998, and 2000 were conducted by the Alaska Fisheries Science Center, Seattle, USA. The 1999 survey was conducted by Japan Fisheries Agency.

Table 12. Estimates of biomass at age (metric tons) from February-March echo integration-trawl trawl surveys* of pre-spawning pollock near Bogoslof Island. No survey was conducted in 1990.

Age	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
0	0	0	--	0	0	0	0	0	0	0	0	0	0
1	0	0	--	0	0	0	0	10	0	0	0	0	0
2	0	0	--	170	0	0	0	0	0	0	0	0	0
3	0	0	--	0	162	284	0	681	0	0	0	0	0
4	0	2184	--	715	782	18809	13028	3411	322	87	78	1809	405
5	14997	7275	--	6067	21455	11939	59938	48690	3668	2083	6771	5688	4177
6	192324	41140	--	24911	38081	39100	21530	208409	69106	10598	37697	28096	2580
7	155569	241301	--	143024	67027	43049	39768	82680	165354	49598	29637	77751	12377
8	114725	111156	--	74575	59445	46874	39107	72294	75658	94580	73714	37210	27748
9	251417	149143	--	149035	67358	43976	39539	96260	45732	44076	94394	59688	15696
10	910016	68495	--	43519	56969	30688	20520	64202	45360	37822	40417	90284	37613
11	226380	894895	--	94020	61394	59294	31589	70646	31116	22942	35706	35240	64846
12	232810	187280	--	59273	36293	27008	27506	26482	33262	22497	29180	32724	32681
13	167054	193548	--	377521	37218	29947	17038	77225	16950	18074	26690	29864	26732
14	81596	71920	--	116171	150237	46997	10896	42417	48990	10713	26304	18915	16328
15	22969	81447	--	38750	168966	107062	52899	16595	24443	19768	13230	14207	15651
16	16336	24342	--	37870	63304	54401	42771	37907	5538	6659	21631	12723	16990
17	6681	51725	--	30696	9342	27577	32128	131396	20782	5470	8218	9635	6281
18	2863	0	--	32392	15467	10736	17911	74010	43092	16894	10212	7020	9763
19	0	0	--	55116	23380	13607	4768	22292	31760	17174	13047	3357	5768
20	0	0	--	3840	43605	11963	5081	5902	14486	9228	19016	4343	2897
21	0	0	--	1341	15240	10167	8866	5433	4023	1885	5376	3574	1061
22	0	0	--	0	3186	1329	2011	7728	1974	947	1078	2668	1177
23	0	0	--	0	1287	598	2323	6696	661	419	0	514	0
24	0	0	--	0	0	0	860	2758	0	888	0	0	631
25	0	0	--	0	0	0	0	0	0	0	0	0	0
Totals	2395737	2125851	--	1289006	940198	635405	490077	1104124	682277	392402	492396	475311	310402

* Echo integration-trawl surveys in 1988-1998, and 2000 were conducted by the Alaska Fisheries Science Center, Seattle, USA. The 1999 survey was conducted by Japan Fisheries Agency.